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Economics of Wheat and Mustard Mixture

M. L. Gupta, V. K. Kaushik & Ramaji Sharma

Wheat and Mustard is a common irrigated crop mixture of the Agra tract. The cultivators believe that the mixed sowing of these two crops is better than growing of any one crop singly due to the reasons—(1) that mustard supplies extra yield without causing much reduction in the yield of wheat, (2) that the root system in wheat is shallow and in mustard deep due to which the two crops do not compete for moisture and nutrients from the same zone of soil, (3) that mustard when sown in association with wheat is less affected by pests then when grown alone and (4) that both crops have the same cultural requirements.

But no systematic efforts appear to have ever been made to substantiate the above beliefs by proper experimentation. From the point of view of the growers the most potent question is—wheather wheat pure is more profitable or its mixture with mustard? To offer a satisfactory answer to this question two other important aspects, of this mixture, need also to be studied—(1) what should be the optimum distance between mustard rows in a wheat mustard mixture and (2) which is the most suitable type of mustard, out of three, normally, sown in association with wheat, *viz.* sarson (*B. compestris* var. sarson), Laha (*B. nigra*) and Rai (*B. juncea*).

This paper embodies the results of an experiment, conducted at the Balwant Rajput College Experimental Farm, Bichpuri, Agra, during the wheat seasons (October to May) of 1956-58, to study the comparative economics of wheat pure *vs.* its mixture with mustards.

Experimental Technique :

The experiment consisted of seven treatment combinations comprising of one treatment of wheat pure and the rest six of three varieties of mustard (Yellow sarson 151, Laha T. 101 and Rai T. 11) each sown, in wheat crop, at two distances, between rows, of 6 feet and 9 feet. 'Complex Randomised Block' design of layout, with four replications, was adopted.

The experimental crops were sown on different, but comparable, fields of the farm in the two years. The crops were sown on 3rd November, 1956 and 30th October, 1957. Wheat, Pb. 591, was seeded at 30 srs. per acre and the mustards at a uniform rate of 8-12 chs. per acre depending on the distance between rows. The sowing was done with a *nai*, a wooden spout attached to a country plough. The crops were sown without palewa (presowing irrigation), but the subsequent demand of crops

for water was met with irrigation. Depending on the occurrence of winter rains the first year crop was given one irrigation and the second year crop four irrigations. To keep the crop free from weeds a weeding was done each year.

Results :

The average yields of grain and straw, per acre, for wheat and of grain only for mustards (the straw of mustards is not of much economical value), and the gross incomes per acre for different treatments, are given in Table 1.

TABLE 1.

Yields and Gross Incomes from wheat and mustards per acre, 1956—58 (in mds. and rupees).

Treatments	1956-57				1957-58			
	Wheat		Mustards	Gross	Wheat		Mustards	Gross
	Grain	Straw		Income	Grain	Straw		Income
Wheat				Rs.				Rs.
Pure	20.4	50.3	...	558.90	16.2	38.1	...	438.00
Mixed	14.7	42.0	3.2	509.60	12.9	29.9	3.0	431.00
S. E.	0.7	2.2	...	...	0.2	1.0	...	...
C. D. at 5%	2.1	6.6	...	...	0.7	4.5	...	...
Mustards								
Y. S. 151	16.6	46.0	1.9	527.00	13.5	31.2	1.6	411.00
Laha T. 101	12.7	37.5	4.6	490.70	12·8	30·4	3·7	447.00
Rai T. 11	14.9	42.6	3.1	509.50	12.4	28.0	3.8	434.00
S. E.	0.5	1.5	0.3	...	non-sig.	non-sig.	0.1	...
C. D. at 5 %	1.4	4.3	0.9	...			0.4	...
Distance between Mustard Rows								
6 feet	14.1	40.4	3.6	504. 0	12.2	22.7	3.5	410.00
9 feet	15.3	43.7	2.8	515. 5	13.5	31.1	2.5	430.00
S. E.	non-sig.	non-sig.	0.2	...	non-sig.	non-sig.	0.1	...
C. D. at 5%			0.7	...			0.3	...

N.B.—The rates of commodities used in calculations :

Wheat grain	...	Rs. 20 per md.
Wheat straw	...	Rs. 3 per md.
Yellow mustard 151	...	Rs. 30 per md.
Laha T. 101	...	Rs. 27 per md.
Rai T. 11	...	Rs. 27 per md.
Average rate for mustards	...	Rs. 28 per md.

It is seen (Table 1) that the wheat, when sown pure, yielded significantly more grain and straw, per acre, in both the years, than when sown in association with mustards ; the per cent increases being 38.2 and 25.6 for grain and 19.8 and 28.5 for straw in the two years respectively. In addition, the mixed crop also produced three mds. of mustard. This reduction in the wheat yields, when sown with mustards, may be ascribed to the smothering effect of mustard plants on the nearby plants of wheat. It was seen that the growth of plants of wheat, as reflected in the number of tillers and dry weight per plant, was much reduced near to the mustard rows as compared with those away from them (Appendix I).

Further, it is noted that the three mustards, tested in this experiment, depressed the wheat yields to different extents. The maximum yields of grain and straw, in wheat, were obtained with Yellow sarson 151 during both the years while minimum with Laha T. 101 in the first year and with Rai T. 11 in the second year. An examination of grain yields of mustards, on the other hand, reveals a reverse trend from wheat yields. Laha T. 101 produced the maximum yield of grain in the first year followed by R. T. 11 and Y. S. 151 respectively. In the second year, however, Laha and Rai gave almost equal yields (3.7 and 3.8 mds. per acre) followed by Y. S. 151. Thus, it is seen that Y. S. 151 is the lower yielder than the other two mustards tried in this experiment. The reverse trend in the wheat and mustards yields may be due to the variations in the nature of vegetative growth of plants of different mustards—the more spreading types reduced the yield of wheat more, due to smothering effect, than the less spreading types. It was noted that the horizontal spread of plants of Laha T. 101 and Rai T. 11 was appreciably greater than that of Y. S. 151.

The distance between mustard rows, in the wheat crop, appears to have some effect on the wheat yields. It is seen that, in both the years, the yields of wheat were greater in treatment of distance between mustard rows of nine feet than with six feet ; the differences being non-significant. However, the six feet distance caused significant increases in the grain yield of mustard over nine feet distance. This may again be due to the smothering effect of mustard plants being more in a crop with less distance between mustard rows.

The gross income, per acre, for wheat pure is higher than for wheat and mustard mixture by Rs. 49.30 in the first year and Rs. 6.60 in the second year. For purpose of comparison the gross income figures are considered satisfactory as there will only be a small difference in the cost of cultivation for wheat pure and its mixture with mustard. The cost of cultivation of the latter (mixture) will be slightly, about Rs. 10.00 per acre, more than that for wheat pure due to cost of seed, sowing, harvesting and processing of mustard. Hence, if net profit per acre is taken into consideration the extent of profitableness of 'wheat pure' will further improve.

From the above results the practice of taking wheat 'pure' emerges out to be better than its mixture with mustards. On large scale farms, where operations like sowing and harvesting for wheat have been highly mechanised, the mixed cropping of mustard, with wheat, aids much to the botheration of the operator. Hence on such farms the cultivation of wheat pure will definitely be advantageous. The small cultivators, who look forward to other advantages of this practice (mixed cropping) also, may continue to grow this crop mixture on a part of their wheat area at some monetary loss. For them Laha T. 101 or Rai T. 11 will be the better types of mustards to be raised in wheat fields and a distance of six feet, between mustard rows, to be optimum.

SUMMARY

This paper embodies the results of a two-year experiment on mixed cropping of wheat and mustards conducted at the Balwant Rajput College Experimental Farm, Bichpuri, Agra, during the *rabi* (October to May) seasons of 1956-58. There were seven treatments in the experiment comprising of one of wheat pure and rest six of three mustard types (Yellow sarson 151, Laha T. 101 and Rai T. 11) each sown at 6 ft. and 9 ft. distance between rows in the wheat crop. 'Complex Randomised Block' design, with four replications, was adopted. Following are the important conclusions :

1. For maximum returns, per acre, the wheat should be sown 'pure' and should not be mixed with mustards unless there are certain other considerations, with the grower, other than income.

2. Laha T. 101 and Rai T. 11 are better yielders than Yellow sarson 151 ; but the latter is more liked for quality. The first two exert more smothering effect on the wheat plants and thus result in greater reduction in the wheat yields. Therefore, the greater yield in mustards is associated with a lesser yield from wheat. The total gross income, per acre, for various associations of mustards with wheat differs by about Rs. 37.00 between the maximum and minimum. Keeping this figure in consideration the grower

may grow any mustard, in his wheat fields, depending on his personal need or market demand.

3. If wheat is sown mixed with mustards the optimum distance between mustard rows should be six feet for better yield of mustard as well as money returns per unit of area.

APPENDIX—I

Growth characters of wheat (within 2′ distance and away from mustard rows) *viz.* plant height in cms., No., of tillers per plant and dry weight per plant in gms.

Treatments	1956-57			1957-58		
	Height	No. of tillers	Dry Weight	Height	No. of tillers	Dry Weight
Close to mustard rows	119.1	2.50	12.80	115.7	4.70	13.47
Away from mustard rows	140.7	3.40	20.10	123.2	7.60	33.47
S. E.	2.9	0.04	0.70	non-sig.	0.50	1.21
C. D. at 5%	8.7	0.11	1.90		2.24	5.47

Effects of Varying Plant Populations and Levels of Nitrogen on the Growth, Yield and Quality of Cotton, 216 F

Onkar Singh and M. L. Gupta,

Introduction :

India is one of the largest among cotton growing countries of the world with an annual area of about 18 million acres. But the acre-yield of this crop is very poor. The average yield per acre of lint in India is only 90 lbs. as against 497 lbs. in U. S. S. R., 428 lbs. in Peru and 417 lbs. in U. S. A. This low yield of cotton in this country may be ascribed to the poor standard of cultivation. This is due, partly, to the absence of necessary information on the standard practices to be followed and, partly, to the financial and other limitations of the growers.

The acre-yield in any crop is the combined function of two main yield contributory factors, *viz.* the yield per plant and the number of plants per acre. In order, to obtain the maximum acre yield a judicious combination of plant population and agronomic practices, conducive to high plant yields, will have to be worked out. The plant yield could, to a great extent, be increased by judicious manuring while an optimum plant population could be ascertained by varying the spacing between rows or between plants within rows, or both. To provide a more precise information on this aspect it appears advisable to workout a combination of soil fertility and plant population capable of giving the maximum yield per acre. This could be arrived at by testing varying plant populations at different levels of soil fertility. Since, like other crops, cotton has been reported to respond most to N manuring, its levels may be used to represent the different levels of soil fertility. This paper summarises the results of an experiment on this aspect of cotton cultivation, conducted at B. R. College Research Farm, Bichpuri, Agra, during the *Kharif* season of 1957.

Methods and Materials :

There were twelve treatment combinations in the experiment comprising of three spacings (9″, 18″ and 27″) between plants within rows (row distance being uniform at 2.5 ft.) and four levels of nitrogen (0, 20, 40, and 60 lbs. per acre). 'Complex Randomised Block Design' of layout, with four replications, was adopted for this experiment.

The experimental crop (cotton, 216 F) was preceded by the first ratoon of sugarcane. The soil of the experimental field was sandy loam in texture and deficient in nitrogen, as is evident from the following results of chemical and mechanical analyses.

TABLE 1.

Results of chemical and mechanical analyses (0-9" depth)

Mechanical analysis		Chemical analysis	
Ingredients	*Percent*	*Ingredients*	*Percent*
Coarse sand	00.82	Nitrogen	0.046
Fine sand	52.70	P_2O_5	0.092
Silt	27.07	K_2O	1.120
Clay	17.42		

A basal dressing of municipal compost (30 lbs. N per acre), was applied, broadcast, 10 days before sowing. The levels of nitrogen were obtained through broadcast application of ammonium sulphate (20% N) in two equal instalments *i. e.* 14 days after sowing just preceding first irrigation and 130 days after sowing when flowering was in progress.

The crop was sown on 17th April, 1957 with pre-sowing irrigation. The seed was dibbled in individual plots according to the treatments of spacing between plants. Three seeds were used per hole to minimise chances of gappiness through faulty germination. The superfluous plants were removed afterwards and efforts were made to fill the gaps through transplanting.

Results and Discussion :

In all, five pickings were done between 4th October and 17th November, 1957. The picking-wise and total yields of seed cotton (in lbs. per acre) were subjected to statistical analyses (Appendix Table 1). It is seen that the variations due to levels of nitrogen came out to be significant in the analyses for 3rd, 4th and 5th pickings and total yield and due to spacings in the analyses for 1st, 2nd, 3rd and 4th pickings and total yields. The interaction, levels of nitrogen X plant spacings, came out to be significant only in the analyses for 1st and 3rd pickings and total yields. The results for the main effects are summarised in Table 2 and for significant interactions in Table 3.

TABLE 2.

Average yields of seed cotton for five pickings and total yields, for four levels of nitrogen and three spacings between plants. (lbs. per acre).

Treatment	Pickings					Total
	1st 4th Oct.	2nd 14th Oct.	3rd 26th Oct.	4th 6th Nov.	5th 17th Nov.	
Levels of N lbs. per acre.						
0	176.0	126.6	170.9	97.5	57.2	628.2
20	212.9	144.4	196.9	104.6	78.8	737.6
40	186.4	150.8	220.9	127.3	111.1	796.5
60	178.3	146.4	212.6	165.0	140.2	842.5
S. E.	13.7	8.3	7.3	5.6	7.2	21.1
C. D. at 5%	Non-sig.	Non-sig.	20.1	15.4	19.9	59.1
Spacings						
9″	220.2	166.3	229.9	126.2	98.1	840.7
18″	195.7	138.5	196.9	131.8	102.9	765.8
27″	149.2	117.9	177.5	113.0	89.4	647.0
S. E.	11.6	7.2	6.6	4.8	6.3	18.5
C. D. at 5%	32.1	19.9	18.4	13.4	Non-sig.	51.2

An examination of data, on the yield of seed cotton, separately, for five pickings in Table 2 reveals that the yield for levels of nitrogen did not differ significantly in the first two pickings, though there were indications that nitrogen applications increased the yields. In the third picking the yield increased significantly from 0 to 20 and 20 to 40 lbs. nitrogen doses, but at 60 lbs. N dose it was slightly reduced. In the rest two pickings the yield increased quite appreciably with every increase in the level of nitrogen. Non-Significant increases in yield, over control (0 lb. N), with nitrogen, in the first two pickings, and significant increases, with

levels of nitrogen, over control, in the last two pickings, may be due to the well known delaying effect of N on crop maturity. Due to this fact the whole process of boll formation and opening started later in nitrogen plots than in control which resulted in lowering the yields of seed cotton in the first two pickings. While the higher yields with nitrogen in the last two pickings may be due to the prolongation of period of boll opening.

The data in the same table reveal that the total yield of seed cotton per acre increased with every increase in the dose of nitrogen (the percent increase over control being 17.4, 26.8 and 35.8 for 20, 40 and 60 lbs. N per acre respectivily), the differences between 0 and 20 lbs. and 20 and 40 lbs. being significant and 40 and 60 lbs. non-significant. On the other hand, the yield per lb. of nitrogen applied, over control, reveals that it decreased appreciably with the increase in the dose of nitrogen, being 5.4 lbs., 4.2 lbs. and 3.5 lbs. for 20 lbs., 40 lbs. and 60 lbs. nitrogen doses respectively. This shows that the efficiency of nitrogen in increasing yield tends to decrease with the increase in rate of its application due to the operation of the law of diminishing physical returns.

It is further seen (table 2) that in all the four pickings the yield of seed cotton decreased significantly with every increase in the plant spacing. It may be visualised that the size of individual plants, in cotton, can not be increased indefinitely either by giving them more space to grow or by applying more nitrogen. Hence, in order to have better yield, probably, the increase in the number of plants in unit area will prove more effective. In the last picking the maximum yield of seed cotton was observed for medium spacing (18″) followed by close (9″) and wide (27″) spacings respectively.

The total yield of seed cotton per acre increased significantly with every decrease in the spacing between plants.

TABLE 3.

Significant interaction : levels of nitrogen x plant spacings on the yield of seed cotton (lbs. per acre).

I and III pickings and total yield.

Spacing between plants	Levels of nitrogen in lbs. per acre					
	0	20	40	60		
1st Picking						
9″	175.4	204.5	237.4	263.6	S.E.	23.3
18″	206.4	250.0	176.4	150.2	C.D. at 5%	64.5
27″	146.3	184.1	145.3	121.1		

Spacing between plants	Levels in Nitrogen in lbs. per acre					
	0	20	40	60		
3rd Picking						
9″	208.3	194.8	227.7	288.8	S.E.	13.3
18″	173.4	199.5	231.6	181.2	C.D. at 5%	36.6
27″	130.8	195.7	203.5	180.2		
Total yield						
9″	696.7	730.6	853.7	1081.4	S.E.	37.1
18″	665.7	819.7	821.7	756.8	C.D. at 5%	102.6
27″	522.3	661.8	714.1	689.9		

An examination of the data in Table 3 reveals that in both the (Ist and IIIrd) pickings, the differences due to the treatments were found significant. The combination 60 lbs. nitrogen and close spacing (9″) gave the maximum yield of seed cotton, while the combination 60 lbs. nitrogen and wide spacing (27″) gave the minimum yields. These results clearly bring out that in cotton the efficiency of nitrogen is increased with the increase in the plant population and hence, it is not of any use to apply higher doses of nitrogen to a sparsely populated crop.

The data in the same table reveal that the maximum total yield of seed cotton (1081.4 lbs. per acre) was produced by the combination of close spacing (9″) and 60 lbs. nitrogen dose and the minimum (522.3 lbs.) by the combination of wide spacing (27″) and 0 lb. nitrogen dose. From these results it may be concluded that (1) the application of nitrogen beyond 40 lbs. per acre, to crops, with low and medium plant population is a waste as it does not increase the yield and (2) dose of 60 lb. nitrogen per acre can be applied gainfully to a crop with high plant population. Most probably, more nitrogen helps plants to counteract the disadvantages to the plants in such a thick crop due to a greater competition between plants.

(B) Quality Studies :

Quality was determined in terms of ginning per-cent and 1000-seed weight. The data on ginning per-cent and 1000-seed weight were subjected to statistical analyses (Appendix Table 2) It is seen that only the variations due to the levels of nitrogen came out to be significant in the analysis for 1000-seed weight. The variations due to the plant spacings, however, in the analysis for 1000-seed weight were just on the verge of significance. The results are summarized in Table 4.

TABLE 4.

Ginning per cent and 1000-seed weight for four levels of nitrogen and three spacings.

Treatment	Ginning per-cent	1000-seed weignt in grms.
Levels of nitrogen in lbs. per acre.		
0	31.6	70.9
20	31.7	73.2
40	31.2	76.5
60	30.5	78.7
S. E.	0.9	1.6
C. D. at 5%	non-sig.	4·6
Spacing between plants		
9″	31.4	72.8
18″	31.3	74.5
27″	31.1	77.2
S. E.	0.8	1.5
C. D. at 5%	non-sig.	non-sig.

From the above results it is evident that the ginning per-cent in cotton is neither affected by the variations in soil fertility nor plant population. However, seed size tended to increase with the increase in soil fertility and spacing between plants *i.e.* decrease in plant population.

(C) Economics of Treatments :

The details of cost and profit for different treatment combinations are given in the following table :

TABLE 5.

Total gross income, cost of cultivation and net frofit per acre for different treatments (in Rs.)

Treatment Combinations Levels of N in lbs per acre. Spacing between plants.	Gross income	Cost or cultivation	Net profit
0×9″	254.88	205.62	49.26
0×18″	243.53	193.95	49.58
0×27″	191.07	190.08	0.99
20×9″	247.29	223.02	44.27
20×18″	299.92	211.35	88.57
20×27″	242.12	207.48	34.64
40×9″	312.31	240.42	71.89
40×18″	303.12	228.75	74.37
40×27″	261.27	224.88	36.39
60×9″	395.62	257.82	137.80
60×18″	276.35	246.15	30.17
60×27″	252.45	242.28	10.17

Inferences from Table 5 :

1. It is seen that the maximum net profit per acre was obtained with the combination of high manuring (60 lbs. N per acre) and close spacing between plants (9″).

2. That high manuring needs a more population to justify its application. For medium and wide (18″ and 27″) spacings the dose of nitrogen should be restricted upto 40 lbs. only.

Summary and Conclusion :

A field experiment was conducted, during the Kharif season of 1957, at the B. R. College Experimental Farm, Bichpuri, Agra, to study the effects of four levels of nitrogen (0, 20, 40 and 60 lbs. per acre) and three spacings (9″, 18″ and 27″ between plants with-in rows), on the growth, yield and quality of seed cotton. The following are the results and conclusions.

1. The application of nitrogen increased the yield of seed cotton per acre. Maximum yield (842.5 lbs.) was obtained with 60 lbs. nitrogen per acre followed, in order, by 43 lbs. (796.5 lbs.), 20 lbs. (796.5 lbs.) and 0 lb. (628.6 lbs.) dose.

2. The yield of seed cotton increased, significantly, with every decrease in the spacing between plants.

3. The maximum yield of seed cotton (1081.4 lbs. per acre) was produced by the combination of close spacing (9") and 60 lbs. nitrogen dose and the minimum (522.3 lbs.) by the combination of wide spacing (27") and 0 lb. nitrogen dose.

4. Levels of nitrogen and plant spacings did not effect the percentage of ginning in the seed cotton. But the seed size increased with the increase in the dose of nitrogen and plant spacing.

5. The maximum net profit per acre (Rs. 137.80) was obtained with the combination of close spacing (9") and 60 lbs. nitrogen dose and the minimum (Rs. 0.99) with the combination of wide spacing (27") and 0 lb. nitrogen dose.

Conclusion :

For the maximum yield of seed cotton and net profit per acre the combination of high dose of nitrogen (60 lbs. per acre) and high plant population (spacing between plants 9") was found to be the best and may be recommended for the cotton growers of the Agra tract on the basis of these results.

APPENDIX TABLE 1

Yield of seed cotton for five picking and total (lbs. per acre)

Analyses of Variance

Variation due to	D. F.	1st picking		2nd picking		3rd picking		4th picking		5th picking		Total	
		M.S.S.	F	M.S.S.	F	M.S.S.	F.	M.S.S.	F.	M.S.S.	F	M.S.S.	F
Blocks	3	4472.4	2.0	1206.9	1.4	3627.8	5.7†	112.9	0.3	957.7	1.5	4472.4	2.0
Nitrogen	3	3568.9	1.6	1264.8	1.5	5625.6	8.9††	11078.9	29.4††	15688.9	24.9††	3568.9	1.6
Spacings	2	21616.7	9.6††	9258.8	11.2††	10058.9	15.8††	1505.3	4.0†	743.5	1.2	21616.7	9.6††
Interaction : NXS	6	5872.9	2.6†	925.9	1.1	3443.8	5.4††	778.9	2.1	655.3	1.1	5872.9	2.6†
Error	33	2258.9		826.7		634.2		376.3		630.1		2258.9	

† Significant at 5%.

†† Significant at 1%.

APPENDIX TABLE 2.

Ginning per cent and 1000-seed weight

Analyses of Variance.

Variation due to	D. F.	Ginning per-cent		1000-seed weight in gms.	
		M. S. S.	'F'	M. S. S.	'F'
Blocks	3	2.9	0.3	37.0	1.1
Nitrogen	3	2.9	0.3	145.4	4.4†
Spacings	2	24.9	2.4	80.2	2.4
Interaction :					
NXS	6	4.6	0.4	16.3	0.5
Error	33	10.1		32.8	

† Significant at 5%

Studies on the Interplay of Factors Influencing the Performance of Sweet and Kagzi Lime Cuttings.

D. N. Das, Birbal Singh, G. N. Parida and R. P. Singh.

Vegetative propagation of plants is the real basis of horticulture enabling us not only to aim at perfection by selection but to perpetuate the advance at will, granting our choices everlasting life. Of all the methods of vegetative propagation, that by cuttings is the most convenient and the cheapest. Its importance is still greater in species like limes where the presence of thorns increases the difficulties in propagation by other methods.

The survival of cuttings improves with an increase in the age of the tissues, but unfortunately this reduces their rooting ability. The rooting of the cuttings is also positively correlated with the vigour of the source shoots (Singh, Garner and Hatcher, 1957). Softwood cuttings are more sensitive and, therefore, endowed with greater rooting potential. In some of the species, where harder cuttings generally fail to root, softwood cuttings have given highly promising results particularly when planted under mist or polythene covers (Garner, 1958). Use of suitable growth substances has been of considerable help in improving the performance of cuttings of various species.

In the experiments, described here, an attempt has been made to study the effects of variations in the source, type of cuttings, growth substance and planting environment on the performance of sweet and kagzi lime cuttings.

Experiment I.

On 12th September, 1955 hard and semi-hardwood cuttings of sweet and kagzi lime were obtained from bearing trees. The cuttings were treated with 0, 200, 400 and 600 p. p. m. of Beta-indole-acetic acid by the dilute solution method, the period of immersion being 24 hours. The experiment consisted of four replicated blocks and each block had sixteen randomized plots. A border of 1′ was also left all round the blocks. Twelve cuttings were planted in each plot in three rows of four cuttings each at a distance of 1½ feet each way, the size of a plot being 6 feet by 4 feet. The cuttings were finally recorded after three months on 12th December, 1955.

Results :

Sweet lime was far superior to kagzi lime in the rooting of both hard and semi-hardwood cuttings (Table I). Semi-hardwood cuttings of both the limes gave more than twice rooted cuttings than the hardwood ones, but even the latter of sweet lime were about three times better in rooting than the former of kagzi lime.

TABLE I.

Percentage of cuttings rooted as affected by the type of wood of the two limes.

Type of limes	Hardwood	Semi-hardwood	Average
Sweet lime	17.2	41.7	29.4
Kagzi lime	2.6	6.3	4.4
Average	9.9	24.0	

C. D. for main treatments 4.76

C. D. for interaction 6.73

Though the effect of the concentrations of hormone as well as that of the interaction between the hormone concentrations and other factors was not significant statistically, the highest over all percentage of 19.75 rooting was obtained by the application of 200 p. p. m. IAA in comparison to the lowest of 13.54% obtained under control.

Experiment II.

It was noted in the former experiment that semi-hardwood cuttings of both the limes performed better than hardwood ones, but the rooting percentage was not very high. Further attempts were, therefore, made to find out some method of increasing the rooting of such cuttings.

Retention of some leaves on semi-hardwood cuttings in certain cases has been found to improve the performance of these cuttings (Garner, 1944). Treatment of cuttings with sugar solutions prior to planting has also been found to increase rooting in certain species. In the second experiment, here reported, semi-hardwood cuttings of the two limes with (3 leaves) and without leaves were treated by 200 p. p. m. IAA, 2% sucrose solution and a mixture of these two. There were again, therefore, 16 treatment combinations including the control. The experimental procedure was the

same as of the first experiment. The cuttings were planted on 17th Feb., 1956 and finally recorded on 3rd May, 1956.

Results :

The sweet lime cuttings in this experiment, too, rooted much better than kagzi lime ones (Table II). The retention of leaves on the cuttings produced an adverse effect on their rooting. The rooting percentage of leafless cuttings of sweet lime was double of that of leafy ones, but there was not much difference in the rooting of two types of Kagzi lime cuttings.

TABLE II.

Effect of retention of leaves on the rooting percentage of Kagzi and Sweet lime semi-hardwood cuttings.

Type of limes.	Leafy cuttings.	Leafless cuttings.	C. D. at 5%
Sweet lime	25.5	52.6	7.59
Kagzi lime	7.3	9.8	

The application of IAA and sucrose to the leafy as well as leafless semi-hardwood cuttings of Kagzi lime did not improve their rooting. In the case of Sweet lime also there was little effect of these treatments so far as the leafy cuttings were concerned, but the rooting of leafless cuttings was better particularly when the cuttings were treated with a mixture of the two substances (62.5% rooting as compared to 41.7 under control, Table III).

TABLE III.

Effect of IAA and sucrose on the rooting percentage of leafy and leafless semi-hardwood cuttings of Sweet lime.

Type of cuttings	Control	200 p. p. m. IAA.	2% sucrose	200 p. p. m. IAA and 2% sucrose.	C. D. at 5%
Leafy cuttings	23.0	23.0	27.1	29.2	21.51
Leafless cuttings	41.7	50.0	56.2	62.5	

Experiment III.

A further effort was made to increase the rooting percentage of the Sweet lime cuttings by trying different concentrations of IAA and IBA applied by the concentrated dip method, which is more convenient and practical. The performance of hardwood cuttings from normal shoots was compared with those from water sprouts, which are more vigorous. The concentrations tried in this experiment were 0, 250, 500, 750 and 1000 p. p. m. in 50% alcohol. The twenty treatment combinations thus obtained were replicated four times, each plot consisting of 16 cuttings at a distance of 1′ each way in a 4′×4′ bed. The cuttings were planted on 28th August, 1956 and finally recorded on 19th December, 1956.

Results :

The two hormones tried in this experiment did not differ much in their effect on the rooting of cuttings. The cuttings taken from water sprouts proved markedly superior to those from normal shoots (Table IV). The rooting of cuttings improved very much by the application of hormones and it seems 500 p. p. m. is the most appropriate concentration, which in case of water sprouts gave 85.9% rooting.

TABLE IV.

Percentage of cuttings rooted as affected by source and hormone concentrations.

Source of cuttings	0 p. p. m.	250 p. p. m.	500 p. p. m.	750 p. p. m.	1000 p. p. m.
Normal shoots	45.2	59.3	64.2	60.9	63.3
Water sprouts	57.8	63.9	85.9	67.5	71.9
		C. D. at 5%	9.57		

Experiment IV.

Since hard and semi-hardwood cuttings of Kagzi lime gave very poor results, an attempt was made to find out the possibility of its propagation by softwood cuttings, which are more sensitive and endowed with greater rooting potential.

Softwood cuttings of Kagzi lime from 15 year old trees were taken from the current (about 2 week old) and previous (about 10 week old) flush of normal trees as well as those dehorned about 6 months back. Three inch long cuttings were planted in 3 inch pots filled with a mixture of equal parts of river sand and sieved leaf mould on 1st September, 1957 and the pots were kept in the partial shade of lath

house with and without polythene (500 gauge) covers. The cuttings were finally recorded 12 weeks after planting on 24th Nov., 1957.

Results :

The cuttings taken from the current flush were too soft and died without any rooting in both the environments. The cuttings of the previous flush from both normal and dehorned trees performed much better in all respects under polythene covers than without them (Table V) and as high as 52.5% rooting was obtained under these covers. The effect of dehorning on the performance of cuttings was not, however, very clearly marked.

TABLE V.

Rooting and shoot growth of Kagzi lime softwood cuttings as affected by the environment and source.

Treatments		Percentage of cuttings rooted.	No. of roots per cutting.	Length of the longest root in m.m.	Percentage of cuttings sprouted.	No. of leaves on longest sprout.
Partial shade	Normal trees	15.0	1.0	30.0	12.5	0
„	Dehorned trees	22.5	1.6	51.5	58.3	0.6
Polythene covers in partial shade.	Normal trees.	52.5	2.4	74.1	88.8	1.2
„	Dehorned trees	35.0	3.1	85.6	100.0	2.8
Partial shade		18.8	1.3	40.8	35.4	0.6
Polythene covers in partial shade		43.8	2.8	74.9	94.4	2.0
C. D. at 5% for main treatments.		8.15	0.38	22.59	33.32	1.11

Discussion :

The results of these experiments have shown the paramount importance of the source of cuttings. The performance of sweet lime cuttings was far superior to those of kagzi lime and in the case of former, semi-hardwood cuttings rooted much better than the hardwood ones. The cuttings taken from water sprouts, again, performed much better than those from normal shoots. The chief factor responsible for these differences appears to lie in the vigour of the source shoots. These results, thus, confirm the findings of Singh, Garner and Hatcher (1957) who found a direct correlation between the vigour of the source shoots and the rooting of their cuttings. The leafless semi-hardwood cuttings of sweet lime performed better than the leafy ones, probably because of greater loss of water causing early death in the latter.

Sweet lime cuttings benefitted much from the treatment of a mixture of 200 p. p. m. IAA and 2% sucrose solution when applied by the dilute solution method. The growth substances (IAA and IBA) when applied by the concentrated dip method, also were quite effective and a very high rooting (85.9 in water sprouts) was obtained at a strength of 500 p. p. m. This shows that the woody cuttings of this variety need a stimulus of growth substances for better performance.

The rooting of hard as well as semi-hardwood cuttings of kagzi lime was very poor as it was less than 10% in all cases. These cuttings were non-responsive to the changes in source or growth substance treatments tried in these experiments. This variety, however, gave very promising results when propagated by softwood cuttings, indicating that in shy rooter like this, more sensitive cuttings should be taken in order to achieve satisfactory results.

The tip cuttings of the current flush were only about 2 weeks old with very young small leaves. They, no doubt, possessed a very high rooting capacity, but unfortunately were too soft to survive long enough to produce roots. The better survival of the cuttings of previous flush, which were about 10 weeks old with full mature leaves, enabled about half of the cuttings to root and establish.

Polythene covers have been reported to provide a very suitable environment for the rooting of softwood cuttings (Johnston, 1958). In the present experiment also the performance of the tip cuttings under polythene covers in partial shade of lath house was markedly superior than without these. Maintenance of high humidity in these covers along with free exchange of gases and availability of some light enables the cuttings to survive for a considerable period for the production of missing parts.

The effect of dehorning the trees was not very perceptible because the operation was done about 6 months earlier and the trees came into flush thrice by the time the cuttings were taken. They, therefore, behaved almost similar to normal trees.

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Summary :

A series of four experiments investigating the possibilities of propagation of sweet and kagzi lime by cuttings, have been described in the present paper. The performance of the semi-hardwood cuttings was much better than hardwood ones in case of sweet lime. Removal of all leaves from the former type of cuttings proved better than retention of three leaves on each cuttings. The cuttings taken from water sprouts which are more vigorous, rooted much better than those from normal shoots. Sweet lime cuttings benefitted considerably from the treatment of 200 p. p. m. IAA along with 2% sucrose solution by the dilute solution method and 500 p. p. m. IAA and IBA by concentrated dip method.

The performance of hard as well as semi-hardwood cuttings of Kagzi lime in these experiments was extremely poor. Softwood cuttings, on the other hand, gave very promising results and upto 52.5% rooting was obtained when they were taken from the shoots about 10 weeks old and put under polythene covers in the partial shade of lath house.

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The Influence of Time of Operation and Technique of Lopping on the Success of Budding of Sweet Oranges.

M. S. Bhadauria, Balbir Singh, R. G. Maiti and S. M. Singh.

Sweet oranges are commercially propagated by bud-grafting (budding) in India. The percentage of success in this operation has been found to vary greatly with the time when the operation is done. Naik (1949) found July and September as the best time for budding for south India, while Hayes (1953) reported early spring and early rains as the most favourable season for north India. Agra is famous for raising citrus plants and the nurseries of this place supply these plants to different parts of the country. Here the budding is commercially done in spring, but the percentage of success is only 30 to 40. It was, therefore, thought desirable to study the success of budding in different seasons.

The suitability of the time of budding is indicated by the ready separation of the bark from the wood (Kains and McQuesten, 1956). During this time the cells of the cambium layer of both the scion and the rootstock are actively dividing. Under the climatic conditions of Agra region citrus trees come into flush a number of times in the year and, therefore, may be successfully budded at different times.

Success of budding is also considerably influenced by the methods of lopping of rootstocks. Naik (1949) obtained advantage of earlier bud-break in sweet oranges by lopping the rootstock soon after budding, while Hayes (1953) recommends lopping when the buds begin to sprout. In these experiments, therefore, the influence of different dates of budding in each season and various methods of lopping was studied on the success of budding.

Trial I.

Experimental procedure.

In this experiment Malta (Citrus sinensis, Osbeck) was taken as the scion mother plant and Khatta (Citrus aurantium, Linn.) as the rootstock. The method of T-budding being common in this part of the country, was employed in this trial. The wood was removed from the bud-shield before insertion. The operation was done on four dates i.e., Feb. 10, Feb. 20, March 2 and March 12. The following methods of heading back of the rootstock were taken up :—

(1) Complete heading back just after budding,

(2) Complete heading back after bud-break,

(3) Complete heading back after the budling was 2 inches long,

(4) Half cut given just after budding, and complete removal after the bud-break,

(5) Half cut given just after budding and complete removal after the budling was 2 inches long, and

(6) Half cut given after the bud-break and complete removal after the budling was 2 inches long.

The observations were taken upto 90 days after budding. The success was judged by the number of buds growing at the time of the final observation. The buds that were still green but did not show any sign of growth were classified as 'dormant buds'.

Experimental findings.

The effect of different dates of budding was very marked in the case of 'per cent success' as well as 'per cent dormant buds' (Table I). Plants budded on Feb. 20 resulted in as high a success as 52.0 percent. The percentage of dormant buds was also considerably low in this treatment. Plants budded on March 12 showed the poorest performance. The budlings of the first budding (Feb. 10) attained the maximum length and those of the last the minimum.

TABLE I.

Effects of date of operation on the performance of bud-grafts.

Date of budding	Per cent Success	Per cent dormant	Length of budling in cm.
Feb. 10	22.0	27.0	6.5
Feb. 20	52.0	9.0	3.5
March 2	31.0	5.0	4.4
March 12	11.0	9.0	1.8
C. D. at 5%	20.4	11.0	2.7

Though the different methods of heading back had no significant effect on the 'per cent dormant' buds, they considerably influenced the 'per cent success' as is evident from Table II. The highest percentage of success was achieved by heading the rootstock back after the buds sprouted. In general the lopping of the rootstocks in one instalment was found to be better than that done in two instalments, though the difference was sometimes statistically non-significant. The same was true regarding the length of budling also.

TABLE II.

Effects of different methods of heading back.

Treatment	Per cent success	Length of budling in cm.
Complete heading back just after budding.	33.0	6.55
Complete heading back after bud-break.	54.0	8.68
Complete heading back after the budling was 2 inches long.	25.0	4.36
Half cut given just after budding and complete removal after the bud-break.	24.0	2.13
Half cut given just after budding and complete removal when the budling was 2 inches long.	15.0	2.53
Half cut given after the bud-break and complete removal after the budling was 2 inches long.	21.0	4.54
C. D. at 5%	24.7	3.41

Trial II.

Experimental procedure.

The success achieved in the above experiment was so variable at different dates in the same season that it was thought desirable to carry out the experiment at different seasons. Since complete removal of the stock, in general, was better than the heading back in two instalments, the latter methods were abandoned in the present experiment.

The different seasons under study were spring, summer and rain. The various dates of budding in the respective seasons were as follows :—

Spring—Feb. 8, Feb. 28 and March 20.

Summer—May 10, May 30 and June 20.

Rains—Aug. 10, Aug. 30 and Sept. 20.

In this trial grown up Mosambi (Citrus sinensis, Osbeck) trees were taken as scion mother plants. The rootstock and the method of budding were the same as in the previous experiment. The observations were taken at 15 days interval upto 165 days after budding.

Experimental findings.

The effect of season of budding was very prominent in this experiment. Contrary to the popular idea that spring is the best time for budding, it was found that the highest success was obtained when the budding was done in the rains. Summer stood second in merit and spring proved to be the worst (Table III). The gradation was reverse in case of dormant buds.

TABLE III.

Effects of different seasons on the success of budding.

Season	Per cent success	Per cent dormant
Spring	23.05	30.80
Summer	38.05	18.30
Rainy season	50.00	13.15
C. D. at 5%	7.5	5.35

There was considerable variation in the results obtained on different dates of the three seasons (Table IV). Budding on 20th June gave the best result with as high as 71.65% success, but the average for this season was considerably pulled down because of very poor results of May-budding.

TABLE IV

Effects of different dates on the success of budding.

Dates of budding			Per cent success	Per cent dormant
Spring	Feb.	8	23.30	38.30
	Feb.	28	17.50	30.00
	March	20	28.30	24.15
Summer	May	10	10.80	11.65
	May	30	31.61	25.00
	June	20	71.65	18.30
Rains	Aug.	10	60.00	10.00
	Aug.	30	43.30	17.50
	Sept.	20	46.65	15.00
C. D. at 5%			13.40	9.25

Different methods of heading back, though having no significant effect on the success of budding, influenced the percentage of dormant buds considerably (Table V). The lowest percentage of dormant buds was noted when the rootstock was headed back just after budding. However, the difference between the lopping 'after the bud-break' and that 'after the budling was 2" long,' was not appreciable. The length of the budling was also significantly affected by this treatment. The budling was longest when the rootstocks were headed back just after budding. The length was found to decrease gradually as the interval between the budding and heading back increased.

TABLE V

Effects of different methods of heading back on the performance of bud-grafts.

Method of heading back	Per cent success	Per cent dormant	Length of budling (cm.)
Just after budding	33.85	14.50	16.38
After the bud-break	36.35	25.55	14.05
After the budling was 2" long	32.45	23.30	11.33
C. D. at 5%	—	5.35	3.45

DISCUSSION

The results of these experiments have shown that the best time for budding of sweet oranges on khatta stock in this region is the third week of June when the temperature is quite high and the humidity of the atmosphere also becomes high because of the monsoon winds. The stock at this time is in active growth and the union takes place in a short time. There is little risk of damage from rains at this period, because the rains come in this part of the country some time in early July. Earlier part of dry summer did not prove very suitable due to strong desiccating winds which dry out most of the buds before the union takes place.

Budding early in August also proved quite suceessful, since there was no heavy rain for over a week after budding. It seems, therefore, that budding at this time may also be preferred over spring because the results are far superior. The use of adhesive tape and polythene strips for tying the bud joints has further increased the possibility of rainy season budding even against the risk of showers soon after the operation. It may, therefore, be appropriate to foresee the gradual replacement of the present practice of large scale budding in spring by that in late summer and early rains by the use of these materials. Spring budding is popular at present inspite of poor results only because it is a very safe period.

Of the various methods of heading back followed in this experiment complete removal of the top of the rootstock after bud-break was found to be the best. In this method the inserted scion bud gets the advantage of the top of the rootstock during the period the union is taking place ; but after it has united the removal of the top of the rootstock above the union makes it the sole recepient of all supplies from the rootstock. This enables the scion bud to grow at a rapid rate.

When lopping is done just after budding, the stock may let the inserted bud unite and then grow, or activate its own dormant buds for producing new leaves. Since the former may take longer time, the stock mostly prefers the later course resulting in a low percentage of success in budding. Removal of the top of the rootstock after the budling is 2" long seems to be a delayed process. Consequently, even the buds, which would have normally grown, had greater supplies from the rootstock been diverted to them in time, result in failure.

Lopping of the rootstock in two instalments was an attempt to combine the merits of early removal and the retention for longer period ; but unfortunately it achieved neither.

SUMMARY

A series of experiments were carried out at the Horticultural Research Station of B. R. College, Agra on the propagation of citrus by budding. Two of these experiments are described in the present paper.

In these experiments sweet oranges (Citrus sinensis, Osbeck) were budded on khatta (Citrus aurantium, Linn.) rootstocks. The wood was removed from the bud-shield before inserting it in the T-shaped matrix. Budding was done at different dates in spring, summer and rains, and different methods of heading back were tried.

The best time for budding was found to be the later part of June when the humidity of the atmosphere rises due to the monsoon winds. Early August was the next best time for budding in citrus. Budding in spring gave the poorest result. The practice of budding in spring may, therefore, be gradually replaced by that in late summer and early rains because of high percentage of success and the reduction in the risk of damage by rains with the use of polythene strips and adhesive tapes.

Heading back of the rootstock after the bud-break was found to give the highest percentage of success. Lopping just after budding initiated the growth of the bud earlier, but the bud-take was adversely affected by this operation. Lopping in two instalments did not improve the result.

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Comparative Efficiency of Cow and Buffalo as Producers of Milk.

A. B. Nabar, D. S. Saraswat and S. N. Singh.

Introduction :

Unlike Europe or America where wilk is mainly produced by cattle alone, both cows and buffaloes constitute the primary source of producing milk in India. The buffalo gives a higher average yield of milk having also a higher butterfat content than the indigenous cow. The former is also hardier and reported to utilize the coarse fodders better than the latter for producing milk. Being not a sacred animal, a certain amount of culling is also possible in buffaloes, making quick improvement possible by proper selection, breeding, feeding and management. As a result more attention is usually paid to the buffalo than the cow. On the other hand, the cow is maintained under the village conditions primarily for her male progeny for the plough or the cart, while her milk is generally intended for the home consumption. The buffalo in the villages is kept mainly for milk and ghee production for sale, since her male progeny is seldom used for work.

The general opinion regarding the keeping of the cow or the buffalo for milk production bears diversified views. As a producer of rich milk, the popularity of the buffalo and her economic value under Indian conditions is realised by milk producers who are free from bias, religious or otherwise. However, more emphasis seems to have been placed, particularly since 1947, on the cow. It is argued that from the point of view of general utility and over-all economic returns, the early maturity, and usefulness of her male progeny for work, the cow ultimately becomes more economical than the buffalo. It is doubtful whether this is strictly true when one considers the milk producing capacity of both the animals. Only a small data is available on their relative economic performance.

The present study was undertaken in Agra district, U. P., with a view to ascertain the comparative economic efficiency of these two valuable animals for milk production.

Technique and Plan of work :

In order to determine which of the two animals is a more economic producer of milk, the economic level of production of each of them must be worked out.

For this purpose, the total amount of milk produced and the expenditure incurred on each animal between her two calvings must be calculated and distributed over the same interval of time. This would give the over all average yield and the maintenance cost per head per day respectively. Then the average cost of production per pound of milk could be worked out separately for the cow and buffalo by distributing the average daily expenditure over the average daily production. The lower cost of production per pound of milk would be the factor determining the economic efficiency of the respective animal.

Under the current investigation, the total expenditure was calculated by adding the costs of the following items included therein.

(1) Feed—concentrate, roughage and grazing.

(2) Labour—adult hours of work done on milch animals.

(3) Depreciation—on livestock.

(4) Interest—on capital invested.

(5) Miscellaneous—rent, repairs, veterinary aid, etc.

The returns in terms of money were calculated on the basis of the prevailing market price of the milk produced.

The required information for the above-mentioned details of this study was collected on the basis of a set of 45 questions on the various aspects, put to the producers during the survey period (1955-56). A dozen representative villages of the district of Agra were chosen for the survey work. These were Angoothi, Bilasganj, Nagar, Mudera, Sadarban, Sahara, Amarpura, Chauhatna, Sunari, Panwari, Atoose and Janpura. From each of these villages, six representative milk producers were selected for the purpose of collecting the required information. Similarly a dozen representative producers were selected from different sectors of the Agra town and information on various aspects of milk production inside the town was collected from them.

It may, however, be mentioned that the information collected during this investigation might not be wholly accurate. Like any other survey work, the results presented in this paper will be approximately correct, since the producers of milk under existing conditions in the villages and the town do not keep records. Nevertheless, it has been observed that the producers are quite intelligent people and provide fairly accurate data from their amazing memory of events and things happening around them. Every information so collected from the rural as well as urban producers was also critically examined under the approved standards and set procedures for evaluating feed requirements, labour costs and the milk yields, etc. In

few cases of expressed doubt, certain 'correction factors' were also employed, viz., 'Lactational yield of milk will be approximately equal to the peak yield per day multiplied by 200,' 'A cow will consume 2 to 2.5 lbs. of dry matter per 100 lbs. live weight while a buffalo 2.5 to 3.0 lbs.'

Milk Yields :

The milk yields of the cows and buffaloes included in the present study have been presented in the following table.

TABLE I.

Showing the milk yields of the cows and the buffaloes.

S. N.	Particulars	Village cow	Urban cow	Village buffalo	Urban buffalo
1.	No. of animals recorded	64	32	98	36
2.	Average no. of days in milk	233.7	230.7	256.3	284.2
3.	Average no. of days dry	139.4	126.4	131.7	131.1
4.	Average lactational yield in lbs.	1740.5	1808.9	2709.6	3328.1
5.	Wet average in lbs.	7.4	7.8	10.6	11.7
6.	Over-all average in lbs.	4.7	5.0	7.0	8.0
7.	Coefficient of variation	17.17%	—	9.3%	—

As is evident from the findings presented in Table I, the cow whether kept in a village or town produces on an average, less milk than the buffalo kept under similar conditions. The buffalo has also got a longer lactation than the cow from both village and town. The number of the buffaloes kept in the villages is also larger than the cows, being 1.3 units per family and 7.7 units per village against 0.77 and 5.3 units of cows respectively. The number of the buffaloes kept in the town is predominantly larger than the cows. In the villages, the cows are usually kept for producing milk for home consumption and for their male progeny needed for the agricultural work. On the other hand the buffalo is kept for producing milk and ghee in the village as well as in the town.

The reason for the apparently low status accorded to the cow in the whole tract under this study may be attributed to the impracticability of culling useless and

uneconomic cattle due to religious susceptibilities and the ban on slaughter. The old and uneconomic buffaloes are frequently slaughtered, making effective culling possible and also leaving better animals of this class for milk production. Preference is also given to the buffalo in the villages for her longer productive life, despite slightly late maturity than the cow.

The town milk producer seldom keeps an animal for a long time. His usual practice is to buy a newly freshened animal and dispose her off when she gets dry. Also, the high yielding animals may be generally retained till the fifth or sixth lactation and the regular breeders and pregnant animals are not disposed off on drying.

Maintenance Costs :

The daily feeding and other costs per animal have been worked out from the collected data and presented in the table below.

TABLE II.

Showing the average daily maintenance costs of the cows and the buffaloes (in rupees).

S. N.	Particulars	Village cow	Urban cow	Village buffalo	Urban buffalo
1.	Feeding cost	0.80	1.12	1.14	1.52
2.	Other Costs :				
	(a) Labour and supervision	0.24	0.20	0.25	0.23
	(b) Depreciation	0.03	0.08	0.11	0.22
	(c) Interest	0.02	0.03	0.05	0.06
	(d) Miscellaneous	0.03	0.09	0.05	0.12
3.	Total Cost	1.12	1.52	1.60	2.15
4.	Coefficient of variation	27.01%	—	19.37%	—

From the above table, it may be observed that the total cost on maintenance of the buffalo is more than that of the cow, exceeding by 38.9% in villages and 39.3% in the town. The cost of maintenance of both the animals is also more in the town than in the villages, exceeding by 33.9% in case of cow and 32.3% for buffaloes.

More information could be derived by distributing the cost of each item of expenditure as percentage to the total cost, as has been presented in the following table.

TABLE III.

Showing the percentage of expenditure on different items included in the total cost of maintenance of cows and buffaloes.

S.N.	Particulars	Village cow	Urban cow	Village buffalo	Urban buffalo
1.	Feeding Cost	71.4	73.7	71.2	70.7
2.	Other Costs :				
	(a) Labour and Supervision	21.4	13.2	15.6	10.7
	(b) Depreciation	2.7	5.3	7.0	10.2
	(c) Interest	1.8	1.95	3.1	2.8
	(d) Miscellaneous	2.7	5.85	3.1	5.6
3.	Total Cost	100.0	100.0	100.0	100.0

The Bureau of Economics and Statistics, Government of Bombay (1955)[1] has given the percentages of various items included in the total cost of milk production as : feed 57%, labour 7%, water 1%, rent 9%, salvage 6%, replacement 17% and miscellaneous 3%. According to Ford Sturrock (1940)[2], the percentage distribution of total cost of milk production on various items was 50% on feed, 8% on grazing, 22% on labour, 8% on depreciation and 12% on other items.

A perusal of the findings included in the above table will reveal that under the present study the cost of feed as percentage of the total cost is very high. This may be due to the remarkably low cost on other items mentioned in Table II and III, viz., housing etc., which still continue to be quite low under the present conditions of milk production in our villages and towns. Similarly the percentages of expenditure on labour in the villages for both cow and the buffalo are higher than in the town. The percentage of expenditure on labour in case of cow is also higher than the buffalo. When one examines the actual costs on feeds and labour as given in Table II, it is clear that the difference is much less. The cost of feed for both the animals is lower in the village than in the town. The feeds are usually purchased in the town from outside and part of the cost goes towards harvesting and hauling of these feeds, which in the village form part of the total labour charges and thus increase the cost of labour in the village.

The labour charges for the cow are actually less than those for the buffalo. But the total cost of maintenance for the buffalo is much higher than that for the cow with the result that the percentage of labour charges to the total cost is markedly reduced in case of the buffalo.

Cost of Production of Milk :

The respective costs of production per pound of milk from the cow and the buffalo have been calculated and given in the following table. The cost of production of milk is equal to :

$$\frac{\text{Cost of maintenance per head per day}}{\text{Over-all average of milk produced}}$$

TABLE IV.

Showing the average cost per pound of milk produced by the cow and the buffalo.

S. N.	Particulars	Village Cow	Urban Cow	Village buffalo	Urban buffalo
1.	Over-all average of milk produced (lbs.)	4.7	7.8*	7.0	11.7*
2.	Average cost of maintenance per day (Rs.)	1.12	1.52	1.60	2.15
3.	Cost per pound of milk produced (Rs.)	0.24	0.20	0.21	0.18

(*Note :—Wet averages have been taken for the urban cow and buffalo, since these animals are disposed off on drying,)

From the above table it is clear that the cost of milk produced by the buffalo in both the village and the town is lower, despite her high maintenance cost, than that of the cow from the village and the town respectively. Again, this may also be noticed that the cost of the milk produced in the town by both animals is lower than that of the village milk of the two animals. This sounds a little strange as it is contrary to the common belief. The reason for this is the fact that the milk yields of the animals kept in the town are fairly high as compared to their counterparts from the village. The urban animals are usually kept for the milking period only and they are disposed off on drying with the result that their wet averages and over-all averages are the same. This leads to lowering of the cost of milk produced when calculated as per pound of

it. Similar is the reason for the low cost of buffalo milk, as her over-all average is also much higher than the cow.

Economic Level of Milk Production :

This is main factor in deciding the relative economic status of the animals. This has been worked out on the basis of the following formula. It is equal to :

$$\frac{\text{Cost of maintenance per head per day}}{\text{Market price per pound of milk produced.}}$$

If an animal fails to balance the expenditure on her maintenance with the price fetched in the market for her milk, it will be a liability to the producer. On the other hand if the production of the animal surpasses the economic level, it will be an asset to the owner. The economic level is, however, governed by the prevailing market price of the milk and is, therefore, liable to fluctuate. The economic levels of the milk produced during the present study are given in the table below.

TABLE V.

Showing the economic level of milk production for the cow and buffalo.

S. N.	Particulars	Village cow	Urban cow	Village buffalo	Urban buffalo
1.	Average cost of maintenance per day (Rs.)	1.12	1.52	1.60	2.15
2.	Average market price per lb, of milk (Rs.)	0.16	0.19	0.20	0.25
3.	Economic level of production (lb. of milk)	7.0	8.0	8.0	8.6
4.	Over-all average (lb. of milk)	4.7	7.8	7.0	11.7
5.	Remarks about the level of production	Uneconomic	Uneconomic	Uneconomic	Economic

It is clear from the above table that the cow, due to her low production, is an uneconomic animal in both the village and the town. The village buffalo is also uneconomic, but the urban buffalo is quite an economic producer so far as the wet average of her milk is considered. If the Urban buffalo is also maintained after drying and that her dry period is considered, the over-all average in her case will be only 8 lbs.

of milk. Then she too will be considered uneconomic, as her economic level of production is 8.6 lbs. of milk. Similarly the Urban cow will become still more uneconomic as her over-all average is only 5 lb. against the economic level of 8.0 lb. of milk. In this connection, it may, however, be remembered that the market price of milk is the limiting factor in determining the economic level of production of an animal. The answer to the direct question as to how the producers of the market milk could survive in a losing business, lies in the widespread adulteration of this valuable food article at present.

SUMMARY & CONCLUSIONS

Both cows and the buffaloes are kept for milk production in the villages and towns in India. The present investigation was carried out in Agra district with the object of evaluating the relative efficiency of these two animals for milk production. The necessary information on milk yields, maintenance costs and prevailing prices of milk in the area was collected on the basis of a set of 45 questions from six representative rural producers of milk from each of the twelve selected villages of the district under this study. Similarly the necessary information was also obtained from a dozen representative milk producers of Agra town. The findings of the current investigation are summarized below.

1. The buffalo has got a longer lactation and a higher yield than the cow in both village and the town.

2. Being a better producer of both milk and butterfat, the buffalo can convert a larger percentage of feed into milk and butterfat than the cow.

3. Better type of animals both cows and buffaloes, are kept inside the town. They are also adequately fed and produce more milk than their rural counterparts. The urban buffalo has got the longest lactation and the highest yield.

4. The maintenance costs of the buffaloes are significantly high in comparison to the cows under both village and the urban conditions. Especially higher charges are incurred on their feeding and depreciation.

5. The buffalo, owing to her high yield of richer milk which is sold at a better price, has attained a higher economic status for her in comparison to the cow. More buffaloes are kept in the area than the cows.

6. The cost per pound of the buffalo milk is less than that of the milk produced by the cow. The buffalo is comparatively an economic and efficient producer of milk in both the villages and Agra town.

7. Percentages of expenditure on various items to the total cost of milk produced, compare fairly well with the percentage figures given by other authors.

From these findings it may be concluded that the buffalo is a better suited animal for milk production and must be encouraged and her potentialities for further higher production developed by proper breeding, balanced feeding and careful management.

The cow must also be given full attention as she provides the working bullocks in addition to her milk. Her capacity might greatly be increased for producing more milk through adequate feeding and good management. The U. P. Government have already taken up the breeding programme in the district under the key village scheme of cattle development. What is still more urgently needed is that the producers must be acquainted with the need for and the factors leading to low cost of milk production on which also largely depends the progress of dairy industry in our country.

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1. Bureau of Economics and Statistics, Government of Bombay (1950), "Cost of Production in Aarey Milk Colony."

2. Ford Sturrock (1940), "Farm Accounting And Management."

Carotene Content of Cattle Feeds.

D. S. Saraswat and S. N. Singh

Part I. Distribution of Carotene in Cattle Feeds.

Considerable nutritional significance is attached to carotene as the precursor of vitamin A which controls a number of vital physiological processes in the animal system. The present paper is the first of the three contributed from studies on the carotene content in cattle feeds. It deals with the carotene values of the feeding stuffs commonly fed to the farm livestock in Agra district. These feeds included concentrates, straws, green fodders and also some emergency fodders. For estimating the carotene content of the feeds, the modified method as recommended by Seshan and Sen[1], has been followed throughout this work.

The results are presented in Table I. They clearly indicate that none of the dry fodders commonly fed to livestock contains any significant amount of carotene. The green fodders are much superior in this respect ; but every green fodder is not an equally rich source of carotene. Jowar, Bajra, Maize and some grasses which find a wide use in this area are much poorer in their carotene value than some of the cultivated fodders like lucerne, berseem, oats, carrots and Napier and Guinea grasses.

Like most of the straws, nearly all concentrates are devoid of carotene. Only a few contain traces of it.

The carotene values of the emergency fodders, particularly the tree leaves, come under the range of the commonly fed green fodders. This observation suggests that they could fairly well substitute for the carotene needs of the farm animals during the scarcity periods. The sugarcane tops are especially rich in carotene.

REFERENCE

1. Seshan, P. A. and Sen, K. C. (1942) : Jr. Agr. Sc. 32 : 194-201.

TABLE I.

Distribution of Carotene in Cattle Feeds.

S.N.	Green Fodders Name	Dry matter (per cent)	Carotene in mgs.	Dry Fodders Name	Dry matter (per cent)	Carotene in mgs.	Concentrates Name	Dry matter (per cent)	Carotene in mgs.	Emergency Fodders Name	Dry matter (per cent)	Carotene in mgs.
1	Jowar Chari	27.25	210	Wheat Bhusa	90.0	nil	Cotton seed cake		nil	Jharberi leaves	65.7	156
2	Bajra	28.80	229	Paddy straw	90.0	nil	Linseed ,,		nil	Neem ,,	43.0	187
3	Maize	26.63	260	Arhar straw	91.5	22	Groundnut cake		nil	Babool ,,	32.9	202
4	Oats	17.20	540	Jowar Karvi	85.7	19	Mustard ,,		nil	Shisham ,,	44.15	112
5	Jowar silage	25.0	111	Bajra ,,	90.0	8	Guar (grains)		nil	Pipal ,,	37.5	261
6	Bajra ,,	21.7	135	Dry grass	92.5	7	Jowar ,,		nil	Ber ,,	41.55	273
7	Pasture grass	25.15	358				Barley ,,		nil	Munj ,,	47.55	252
8	Sudan ,,	25.0	347				Gram		3	Dub grass	37.8	312
9	Anjan ,,	20.55	331				Wheat bran		nil	Forest grass	28.0	337
10	Guinea ,,	20.0	423							Sugarcane tops	39.4	358
11	Napier ,,	17.9	525									
12	Guar	29.45	290									
13	Berseem	17.5	440									
14	Lucern	24.5	486									
15	Carrots (roots)	12.51	601									

N. B. The carotene values have been calculated in milligrams per kilogram of dry matter in dry fodder and concentrates, and dry matter contained in leaves of the green fodders.

Agriculture for Town-dwellers.

A. N. Sharma.

I. Introduction. (Nature and Scope.)

The present study is based on the case histories of 12 large-scale farms varying in size from 60 to 350 acres. Two of them are situated in Agra District, four in Mathura District, four in Aligarh District, one in Etah and one in Mainpuri District. The selection of these farms was made primarily with a view of presenting the local agricultural situation. The over-all attempt has been to make this study to represent fairly the prevailing situation of large scale farming in Agra Division of Uttar Pradesh. However, the second important consideration in the selection of the cases was the readiness of farmers to give the detailed information and the availability of farm records with them. The enquiry was conducted during 1955-56. The method of collecting the information was the personal interview during which a schedule of enquiry was filled up. The following table shows the size and location of the farms.

Case No.	Location		Name of the Owner.	Size of Farm. (acres)	Garden (acres)
	District	Village.			
1	Agra	Achhnera	Shiv Prasad Agarwal	200	10
2	Agra	Kailash	Chhidulal Bhargava	80	16.6
3	Mathura	Chhatikara	Rao Krishna Pal Singh	200	10
4	Mathura	Annoda	Ram Rakhash Pal Singh	70	—
5	Mathura	Jagdishpur	Kr. Girvar Singh	60	15
6	Mathura	Chatta	Koshi Farm Ltd.	350	16
7	Aligarh	Gajrauli	Pt. Kishan Lal	80	17
8	Aligarh	Lehra	Prem Chandra	80	—
9	Aligarh	Chirauli	Lalit Narain Dube	120	—
10	Aligarh	Nehra	Bhagwati Prasad	250	—
11	Etah	Tikatar	Kr. Surendra Singh	200	—
12	Mainpuri	Jasrana	Kr. Kaim Singh	76.4	18

N.B.—This paper is a brief adoptation of the thesis submitted by the author to the Agra University for the degree of M. Sc. (Ag.) in May, 1956.

II. Methodology.

There are two approaches in the study of specialization and diversification in farming ; one on the area basis, and the other on the income basis. We approach the problem in both the ways.

(a) The Area Approach.

In the case of large scale farming the general expectation is that there should be considerable specialization and commercialization. About specialization, it is said that at least 40% of the area should be under one particular crop, or at least 40% of the income should be from one source before a farm can be called a specialized farm. Judged from this standard we find that on the whole (taking the total of the 12 cases) there is no specialization since the maximum percentage comes to 32.59% under wheat closely followed by sugar-cane in which the area is 15.68%.

Table showing combination of enterprises (Acres under different crops and percentage, 1954-55):

Crops.	Case Nos.	Size groups (acres) 50—100 2, 4, 5, 7, 8 and 12	100—200 9, & 11	Over 200 1, 3 & 10	Total of 12 cases.
Paddy (Acres)		—	8	—	8
%		—	2.58	—	0.41
Jowar (acres)		26	19	20	65
%		5.00	6.12	2.22	3.76
Bajra (acres)		41	30	46	117
%		7.89	9.7	5.12	6.76
Maize (acres)		21	28	36	85
%		4.04	9.03	4.00	4.92
Til (acres)		—	—	10	10
%		—	—	1.11	0.57
Jowar and Arhar (acres)		9	15	15	24
%		1.73	—	1.77	1.38
Bajra and Arhar (acres)		4	—	6	10
%		0.06	—	1.15	0.58

(Contd.)

Crops.	Case Nos.	Size groups (acres) 50—100 2, 4, 5, 7, 8 and 12	100—200 9 & 11	Over 200 1, 3, & 10	Total of 12 cases.
Sugarcane (acres)		58	44	169	271
%		11.17	14.19	18.82	15.68
Cotton (acres)		14	—	42	56
%		2.69	—	4.68	3.24
Urd (acres)		1	—	5	6
%		0.18	—	0.55	0.34
Moong (acres)		7	2	8	17
%		1.34	0.64	0.88	0.98
Sweet-Potato (acres)		8	—	—	8
%		1.52	—	—	0.56
Tomato (acres)		1	—	—	1
%		0.19	—	—	0.05
Radish (acres)		1	—	—	1
%		0.19	—	—	0.05
Coliflower (acres)		2	—	—	2
%		0.38	—	—	0.10
Sunhemp (acres)		2	—	—	2
%		0.38	—	—	0.10
Fodder Crop (acres)		13	9	4	26
%		3.08	2.90	0.43	1.68
Total of Kharif Crops (acres)		208	140	361	709
%		38.15	45.16	40.20	40.48
Wheat (acres)		170	80	313	563
%		32.75	25.80	34.84	32.59
Barley (acres)		36	31	54	121
%		6.93	10.0	6.01	7.00
Gram (acres)		48	28	65	141
%		9.24	9.22	7.23	8.76
Wheat and Mustard (acres)		11	—	38	49
%		2.11	—	4.23	2.25

(Contd.)

Crops.	Case Nos.	Size groups (acres) 50—100 2, 4, 5, 7, 8 and 12	100—200 9 & 11	Over 200 1, 3 & 10	Total of 12 cases.
Tobacco (acres)		—	—	5	5
%		—	—	0.55	0.29
Pea (acres)		8	18	17	43
%		1.54	5.81	1.89	2.49
Potato (acres)		21	13	35	69
%		4.04	4.19	3.89	3.97
Luffa (acres)		1	—	3	4
%		0.19	—	0.33	0.33
Arbi (acres)		1	—	—	1
%		0.19	—	—	0.05
Brinjal (acres)		1	—	—	1
%		0.19	—	—	0.05
Mirch (acres)		4	—	—	4
%		0.75	—	—	0.23
Fodder crops (acres)		7	—	—	7
%		1.34	—	—	0.36
Total of Rabi Crops (acres)		308	170	530	1008
%		61.85	54.84	59.80	59.52
Grand Total (acres)		516	310	891	1717
%		100.00	100.00	100.00	100.00

Taking the farms individually we find that in the case No. 3, 42.86% area is devoted to a single crop wheat and in case No. 8, 41.30% is again devoted to wheat. In all the remaining cases we find that the percentage devoted to different crops nowhere shows the standrad mark. On the whole (Col. 5 in the above table) wheat is found to have been given preference, in which case the area comes to be remarkably more than that in other cases. Under other crops the proportions are sugarcane 15.68%, gram 8.76%, Bajra 6.76%, Barley 7.00%, Maize 4.92%, Potato 3.97%, Juar 3.76%, Cotton 3.24%, pea 2.49%, Juar and Arhar 1.38%, fodder 2.04%, and under quite a large number of crops less than one percent each. This type of distribution of area under different crops was found in almost all the twelve cases.

It is significant that farming even in such cases remains largely of traditional type of grain cultivation and has almost the same degree of diversification. The most surprising thing is that inspite of most of these farms being suitably located, i. e., enjoying good transport facilities and the proximity of cities being available, these farmers do not take to vegetable growing or market gardening or any other combination of that type.

(b) The Income Approach.

By adopting the income method the following picture is emerged.

Table showing the Annual Gross Income from various sources. (1954–55)

		Size groups (acres)			Total of
		50-100	100-200	Over 200	12 cases.
Crops.	Case Nos.	2, 4, 5, 7, 8 & 12	9 & 11	1, 3, 6 & 10	
Paddy	(Rs.)	—	—	1400	1400
	%	—	—	0.10	0.04
Jowar	(Rs.)	2839	1994	1823	6656
	%	2.42	1.32	1.20	2.1
Bajra	(Rs.)	3584	2555	3510	9649
	%	3.05	3.33	2.32	3.34
Maize	(Rs.)	2813	3465	2586	8864
	%	2.39	4.00	1.71	2.56
Til	(Rs.)	256	—	—	1231
	%	0.13	—	0.64	0.38
Sugarcane	(Rs.)	23030	25880	59886	108796
	%	19.62	33.78	39.66	32.36
Cotton	(Rs.)	736	—	8790	9526
	%	0.61	—	5.75	3.6
Arhar	(Rs.)	777	625	1316	2718
	%	0.66	0.81	0.87	0.9
Urd	(Rs.)	432	—	340	772
	%	0.36	—	0.22	0.2
Moong	(Rs.)	740	176	751	1667
	%	0.63	0.23	0.49	0.4
Potato	(Rs.)	5685	—	—	5685
	%	4.84	—	—	1.78

(Contd.)

Crops.		Size groups (acres)			Total of 12 cases.
	Case Nos.	50-100 2, 4, 5, 7, 8, & 12	100-200 9 & 11	Over 200 1, 3, 6 & 10	
Tomato	(Rs.)	1190	—	—	1190
	%	0.10	—	—	0.35
Radish	(Rs.)	600	—	—	600
	%	0.51	—	—	0.18
Coliflower	(Rs.)	640	—	—	640
	%	0.51	—	—	0.19
Sunhemp	(Rs.)	114	—	—	114
	%	0.09	—	—	0.03
Fodder Crops	(Rs.)	2197	787	2692	5676
	%	2.96	1.02	1.78	1.79
Total	(Rs.)	45633	35482	84069	165184
	%	38.03	51.46	60.72	50.42
Wheat	(Rs.)	42478	19314	33164	94956
	%	36.20	25.20	21.89	29.57
Barley	(Rs.)	3749	4640	1855	10244
	%	3.10	6.05	1.22	3.18
Gram	(Rs.)	5190	2091	4130	11411
	%	4.50	2.73	2.73	3.55
Mustard	(Rs.)	1853	1103	5320	8276
	%	1.57	1.42	3.52	2.57
Tobacco	(Rs.)	—	—	1400	1400
	%	—	—	0.92	0.43
Pea	(Rs.)	695	843	327	1865
	%	0.58	1.10	0.21	0.57
Potato	(Rs.)	9556	5670	5700	20926
	%	8.14	7.40	3.77	6.50
Luffa	(Rs.)	155	—	—	155
	%	0.12	—	—	0.04
Arbi	(Rs.)	1470	—	—	1470
	%	1.25	—	—	0.45

(Contd.)

Crops.		Size groups (acres)			Total of
		50-100	100-200	Over 200	12 cases.
	Case No.	2, 4, 5, 7, 8 & 12	9 & 11	1, 3, 6 & 10	
Brinjal	(Rs.)	1190	—	—	1190
	%	0.09	—	—	0.36
Mirch	(Rs.)	1950	—	—	1950
	%	1.17	—	—	0.60
Total	(Rs.)	68186	33661	519896	153743
	%	56.81	48.54	38.57	46.93
Garden	(Rs.)	6200	—	2500	8700
	%	5.16	—	1.71	2.65
Total	(Rs.)	74386	33661	54396	162443
	%	61.97	48.54	40.26	49.58
Grand Total	(Rs.)	120019	69143	138465	327627
	%	100.0	100.0	100.0	100.0

The largest single source of gross income (taking the total of the twelve cases, Col. 5 in the above table) is sugarcane closely followed by wheat. The percentages are 31.36 and 29.57 respectively. Other crops form very low proportions. The percentage under vegetable is only 12.74 out of which the contribution of potato is 6.50. The share of gram and barley is only 3.55% and 3.18% respectively. Gardens yield very small income 2.65% only. The highest percentage of gross income in Kharif season is received from Cotton, Bajra and Jowar and Maize come next showing 2.6, 3.34, 2.1 and 2.56 % respectively.

III. Productive Efficiency.

In view of the economics of large scale production in this industrial age it is generally believed that bigger the scale of operation greater the productive efficiency. The same belief is held in agriculture. Now let us examine this situation.

Some measures of productive efficiency could not be adopted in this case because of the non availability of the necessary data on these farms. We, however, adopted three methods which were found to be most convenient under the circumstances and the details are as follows :

(a) Costs and returns in relation to the size of farms :—

Table showing productive efficiency in relation to size of farms.

Case Nos.	Net cropped area (Acres)	Total cropped area (Acres)	Operational Costs (Rs. per Ac.) On net cropped area (Ac.)	Operational Costs (Rs. per Ac.) Total cropped area (Ac.)	Gross returns (Rs. per Acre) On net cropped area	Gross returns (Rs. per Acre) Total cropped area	Profit or loss per acre on net cropped Area Profit Rs.	Profit or loss per acre on net cropped Area Loss Rs.
1.	200	220	233 5 1	222 1 11	216 3 9	196 8 9	—	19 1 4
2.	80	100	247 9 1	198 0 11	308 3 0	246 0 10	60 9 11	—
3.	200	216	197 2 8	182 9 1	179 3 10	161 15 0	—	17 8 10
4.	79	79	227 7 7	227 7 7	179 9 10	171 9 10	—	55 7 2
5.	60	79	210 0 5	151 8 11	218 13 1	191 6 2	38 12 3	—
6.	240	248	226 12 1	218 7 1	214 9 4	202 10 11	—	12 2 9
7.	80	88	213 12 2	194 5 3	281 10 4	256 14 0	67 13 2	—
8.	80	84	169 4 7	153 4 3	245 15 8	233 5 0	75 11 1	—
9.	120	140	168 9 9	168 6 9	214 12 3	234 4 6	46 3 9	—
10.	210	220	202 3 4	193 13 3	132 0 5	126 0 4	—	70 2 11
11.	200	200	179 9 7	129 9 7	254 2 9	254 2 0	74 9 2	—
12.	76.4	92	233 10 5	193 9 0	311 14 11	252 4 0	78 4 6	—
Average	135.4	144.5	208 7 4	193 9 8	219 0 9	204 7 4	10 9 3	—

In order to have a more clear idea of the result the above table is consolidated in the form of the following table in which the twelve cases are grouped under three size groups :

Size groups (Acres)	No. of Farms.	Operational cost on net cropped area (Rs. per acre)	Gross return on net cropped area (Rs. per acre)	Net Profit or Loss Profit (Rs. per acre)	Net Profit or Loss Loss (Rs. per acre)
50—100	6	217 2 5	359 10 9	42 8 4	—
100—200	4	197 9 1	216 3 11	4 8 7	—
200—300	2	210 12 7	175 1 1	—	35 11 6

The popular feeling is not confirmed by our results as shown in the above two tables.

On the whole we find that the operational costs per acre on the basis of net cropped area come to Rs. 209/10/- and on the basis of total cropped area Rs. 194/3/11. The gross return per acre on the basis of net cropped area comes to Rs. 221/5/11 and on the basis of total cropped area comes to Rs. 204/6/9. On the whole these twelve farms made a profit of Rs. 11/11/1 per acre during 1954-55.

Seven of these farms made a profit and five suffered losses. The maximum profit was Rs. 78/4/6 per acre in case No. 12 and a maximum loss was Rs. 70/11/2 per acre in case No. 10. The minimum figure for profit and loss were Rs. 38/12/- in case No. 5 and Rs. 12/2/9 in case No. 6 respectively. There is no co-relation between the magnitude of profit and loss and the size of the farms. From the consolidated table we find that the largest group suffered loss and the other two groups made profits. The maximum profit was, however, made by farms of 50—100 acres. The largest farms suffered loss.

(b) Crop yields in relation to the size of farms.

The average yield per acre for the most important crop covering about 70% of area obtained during 1954-55 was as follows :—

Size Groups.	Average Yield Mds. per acre					
	Wheat	Sugar Cane	Gram	Barley	Bajra	Jwar.
50–100	13.50	380	10.5	9.6	7.6	9.1
100–200	10.50	375	7.5	10.0	7.75	8.9
200–300	11.50	300	6.0	5.0	8.5	9.0

The above table reveals that the farms of 50-100 acres gave the best results. In the case of wheat the average for this group was 13.5 where as for the remaining two it was 11.50 for 200-300 acres group, and 10.5 for 100-200 acres group. In the case of Sugar-Cane, Gram and Jwar the highest yield was also on the farms of 50-100 acre. In the case of Barley the maximum yield was on farm of 100-200 acres and in the case of Bajra the maximum yield was in case of farms of 200-300 acre. This is due to exceptionally good barley crop in case of 11 and exceptionally good Bajra crop in the case No. 10. These exceptions, however, should not be treated as normal cases. On the whole we find the farms 50-100 acres giving the best yield.

(c) Crop intensity in relation to the size of farms.

The procedure adopted in calculating the index of crop intensity is : The net cultivated area has been taken as 100. To the net cultivated area we have added

the double cropped area and the area under such crop mixtures in which individual crops mature and are reaped at different times and yield equally signficant incomes as in the case of Jowar and Arhar, Bajra and Arhar and Wheat and Mustard. The case of such mixtures like Wheat and Barley or Jowar and Bajra are of different nature. And such mixtures should be treated as a single crop for such purposes and no further addition be thus arrived at is taken as the total cropped area is calculated. The results which have been obtained are as follows :—

Size Groups.	Index of Crop Intensity.
1. 50—100 (Acres)	110.12
2. 100—200 ,,	107.10
3. 200—300 ,,	104.99

This table shows that the highest index of crop intensity is on the smallest group (50—100 acres) and as the size increases the index declines. This, however, shows two things (1) that on the largest size of farms the land is not being put to maximum use. And (2) that for increasing the total farm business activity intensification is a better remedy.

IV. Machinery.

The following table shows the amount of investment in machinery and we have included all types of machines, implements and tools which have been used on the farms studied :

Case Nos.	Size of the farms (acres)	Total investment in equipment & machines (Rs.)	Investment per acre of net cultivated area (Rs.)
1	200	84,710 0 0	425 0 10
2	80	1,124 0 0	14 0 10
3	200	18,750 0 0	93 12 0
4	79	1,230 0 0	19 1 9
5	60	442 0 0	7 15 10
6	240	28,850 0 0	81 13 0
7	80	12,850 0 0	160 10 0

(Contd.)

Case Nos.	Size of the farms (acres)	Total investment in equipment & machines (Rs.)	Investment per acre of net cultivated area (Rs.)
8	80	13,445 0 0	161 10 0
9	120	539 0 0	4 7 10
10	210	16,500 0 0	65 0 0
11	200	14,020 0 0	70 1 6
12	76.4	13,955 0 0	18 5 6
Total	1625	2,03,638 0 0	123 8 5

The above table shows that the investment per acre of net cultivated area is Rs. 123-8-5. The range of variation, however, is very great from Rs. 4-7-10 to Rs. 425-10-0. It was found to be highest on the Achhnera farm being Rs. 425-0-10. It is a case of almost fully mechanised farm. Besides, in case numbers 7 and 8 it was found to be about Rs. 160-0-0. In the rest of the cases it was quite low. Those cases which show low figures are operated by bullock labour. By arranging the investment on equipment and machinery in relation to different size groups we get the following picture.

Case groups (acres)	Case No.	Total investment (Rs.)	Investment per acre (Rs.)
50–100	6	40489 0 0	88 15 10
100–200	4	118019 0 0	163 14 7
200–300	2	45130 0 0	100 4 7
	12	2,03,638 0 0	123 8 5

The highest investment is found to be in the group II (100-200 acres). This is because one highly mechanised farm falls in this group. If we exclude that farm then the average comes to Rs. 64/- only. In the remaining two groups it was Rs. 88/15/10 in case group I and Rs. 100/4/7 in case group III. The two cases in group III, numbers 6 and 10, are of partial mechanisation.

In some individual cases farmers have taken to mechanisation because of the labour problem, non-availability, and habit of whiling away time. For the country as a whole these arguments do not stand since they aggravate the unemployment problem. As a remedy for such problems of the farmers it will not be safe to suggest mechanization. Under such circumstances labour supply is to be regulated, and mechanization should be considered in relation to the problem of finance, and organisation of the unit of operation in agriculture.

CONCLUSION

In the end we can safely conclude that even in the case of large scale farming the combination of enterprises is the traditional one and the choice of enterprise is also very restricted due to the above said reasons. The land, labour and machines are not used here to the fullest extent because the prime aim of such farmers is to save land from abolition. It may be another thing that during the period of high prices it may prove profitable. But from the point of view of land utilization it should be discouraged as a national policy. Under the present shortage of production, optimum utilization of land and maximum production should be the aim.

On the whole it is a sort of encroachment by cities on villages reducing the farmer to the status of wage earner. Even from the view point of business and profitability in most of the cases it is not desirable. Therefore, farming by town dwellers in villages must be discouraged. It can of course, be tolerated in the vicinity of cities if they have farms nearby cities and practice farming under their close supervision.

Studies in the Family Leguminosae
Subfamily Papilionatae.

Tejesh Chandra Shukla.

Lens esculanta Moench.

The common 'Masur' has been investigated with respect to vernalization anthesis, pollination, gametogenesis and embryology.

Seed and its germination of three varieties, 4315-1, 4328-23 and 4318-4 have also been studied. The percentage of germination of seeds ranges between 85 to 95 in pots and 80-88 in plots.

The roots start branching from the radicle 15 days after sowing and continue branching for the whole of the vegetative phase of 63 days and the entire root system of a plant occupies 285.5 sq. cms.

Branching of a mature plant is of racemose type and shows upto tertiary branches. It is interesting to find that the first branch arises in the axil of second leaf while the second one in the axil of first.

The leaf is stipulate, alternate, pinnately compound. Stipules are acute. Phyllotaxy is 3/5. Number of leaflets in a leaf varies from 2-14, depending on the position of leaf.

Regeneration in *Lens esculenta* Moench is common in all the three varieties studied. For this study various parts of Lens that were cut at different stages of development showed slow growth, but fruiting was normal.

Anthocyanin pigment on stem and leaves on selfing bred true to parental types.

By giving the chilling doses for 32 days the vegetative cycle can be shortened by 21 days. Since in *Lens esculenta* there is no affect on the number of branches by Vernalization treatment, it is presumed to be quite likely that the yield would also not be affected.

The experiments were done in 1949 under the supervision of Dr. Bahadur Singh, Professor of Botany, B. R. College, Agra.

Photoperiodic treatments induced early flowering by reducing the vegetative phase from 63-64 days. Continuous illumination also inhibited the production of secondary branches.

Since the appearance of the flower bud the standard enclosing the wings and keel protrudes out of the calyx on the ninth day. Within next 24 hours the flower opens and remains so between 9 A. M. and 6 P. M., for the total period of 22-24 hours. The microspore mother cells undergo reduction divisions between 11 A. M. and 2 P. M.

Lens esculenta is a normally self pollinated crop. Anthers which are nine days old dehisce between 9. A. M. and 10 A. M. The stigma also remains receptive between 9 A. M. and 12 noon.

A mature anther consists of an epidermis, an endothecium, one middle and a single layered tapetum. The wall layers disorganize at the uninucleate pollen grain stage. A periplasmodium is formed by tapetal degeneration. The epidermis disappears by the time the endothecium develops fibrous thickenings, it thus forms the outermost layers. The author agrees with Maheshwari (1938) in refuting Brough (1924) who is of the opinion that epidermis develops the fibrous thickenings. Meiotic divisions of microspore mother cells results in the formation of isobilateral tetrads. Pollen grains are shed at tricelled stage.

A concentration of 7.5% sugar-agar is found to be necessary for proper germination of pollen grains and the growth of pollen tube.

Ovule is anatropous and bitegmic. The inner integument forms the micropyle. Embryo sac formation follows polygonum type. Mature embryo sac is 7 celled consisting of an egg, two synergids, 3 antipodals and 2 polar nuclei.

Mature embryo possesses four seedling leaves along with 2 cotyledons which are thick, hard, brittle and laiden with food material.

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Studies in Trichosanthes Anguina Linn. and Trichosanthes Dioica Roxb.

R. S. Deshpande.

The present investigation deals with the Morphology, floral biology and Embryology of the plant. A few crosses have also been made to find out the possibility, of using the plant in breeding work.

Ripe seeds of *Trichosanthes anguina* are brown, very hard, flat and oblong in shape bearing grooves on the margin.

Germination experiments were conducted with fresh seeds from the previous crop as well as from stored seeds. Whereas the former showed 80% germination which started only 3 days of sowing the latter showed 44% germination which started 5 days of sowing.

The plants are monoecious bearing white coloured flowers, the male ones form clusters of 12-20 flowers in the axils of leaves while female flowers are solitary. Some hermaphrodite flowers are usually observed on plant in early as well as late season. These are distinguishable from normal ones by their pale yellow colour & flattened ovaries. Such flowers on selfing produced 3"-4" long fruit which are shed.

Male buds take only 17 days to open while the female ones 20 days. Both male and female flowers open early in the morning.

The best time for pollination is between 6 A. M. to 9 A. M. The pollen grains become viable the previous evening to their shedding and remain so for 2 days in winter and only for one day in summer.

Maximum germination of pollen grains takes place in 7.5% sugar-agar solution. They take 15-20 minutes for complete germination. Mostly pollen grains are monosyphonous, but polysyphonic condition is also observed.

Stigma is most receptive between 6 A. M. and 9 A. M.

Intergeneric crosses between *Momordica charantia* female *Trichosanthes anguina* male succeded. While the Fi. showed complete dominance of the characters of male parent, F 2 showed a great deal of variation.

Wall layers of an anther consist of an epidermis, the endothecium, a middle layer and the tapetum.

The experiments were done in 1951 under the supervision of Dr. Bahadur Singh, Professor of Botany, B. R. College, Agra.

Microspore mother cells, after undergoing a prolonged period of rest, divide heterotypically to form tetrahedral, isobilateral and decussate microspore tetrads.

Mature pollen grains are triangular and bear 3 germ pores. They are shed at a tricelled stage.

Ovules are bitegmic. Megaspore mother cells is 4 cell layers deep. In 50% cases atleast both the dyad cells divide giving rise to a row of megaspores which may be arranged either in a linear or T-shaped order. In other 50% cases the upper dyad cell degenerates as such without division giving rise to a row of 3 cells of which the lower 2 are megaspores while the upper one is an undivided dyad cell.

The mature embryo sac is eight nucleate and develops after polygonum type.

Trichosanthes dioica Roxb :

Ovules are bitegmic with the primordia of both integuments appearing at the megaspore mother cell stage.

The megaspore mother cell is deep seated with 15-20 wall layers capping it. It divides twice resulting in the formation of four megaspores which may be arranged in linear order or have the form of an inverted T.

Chalazal megaspore, as well as second megspore from the chalazal end and also the micropylar megaspore, are observed to function.

Mature embryo sac, a 7-celled structure, develops after Polygonum type and possesses an egg apparatus consisting of one egg and 2 synergids, two polars and 3 antipodal cells.

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Studies in Lagenaria Vulgaris Seringe.

J. C. Gupta.

The investigation embodies the findings on vegetative and reproductive morphology, life history along with a few experiments on artificial germination of pollen grains and on breeding.

Germination studies reveal that 81% seeds sprout of which the maximum number do so on the 5th. and 6th. days of sowing. During germination, which is epigeal, a small 'peg' is formed on the concave side of the hypocotyl at its base. This peg holds the testa in the soil as the Cotyledons emerge out.

The plant is an annual, climbing or trailing, pubescent herb with 7' deep tap root system. Simple and trifid tendrils have been reported apart from usual bifid ones. Twin leaves with fused petioles are also sometimes met with.

Both male and female flowers appear on the same branch to start with. As the plant grows older separate branches are formed for the male and female flowers. They are showy the male flowers are shorter than the female. The hermaphrodite flowers are deformed and bear no fruits. Both male and female buds take 15 days to blossom. They generally open in the evening but the time of opening as well as closing is greatly influenced by humidity and temperature. Opening is earlier in winter than in summer and closing is later in winter and earlier in summer. Wind and nocturnal insects are chief agencies for cross pollination. Artificial pollination has shown that best time for it is between 5 to 7 P. M.

Inter generic crosses made between *Lagenaria*, *Momordica*, *Trichosanthes*, *Luffa*, *Cucurbita* and *Cucumis* are found to be unsuccessful. While an intervarietal cross between 'Long' and 'Gola' varieties of *Lagenaria* are found to succeed, the Fi generation showed dominance of the factor of longness of fruits over roundness.

Wall layers of anther consist of an outer epidermis, 2 to 3 middle layers, an endothecium and single layered tapetum. Endothecium develops usual fibrous thickening by the time uninucleate pollen grains are formed. At this time epidermis shows signs of degeneration while the middle layers appear to have been crushed.

The experiments were done in 1951 under the supervision of Dr. Bahadur Singh, Professor of Botany, B. R. College, Agra.

Tapetum is uninucleate in the beginning but it becomes bi-or even trinucleate later on. Reduction division of sporogenous cells is normal. Tetrahedral as well as decussate types of microspore tetrads are observed. Soon after the microspores separate from the tetrads, vegetative and generative nuclei are cut off. The generative nucleus shifts to one side and a definite cell wall is formed round it. Generative cell divides to form 2 male cells. Thus the shedding stage of the pollen grain is trinucleate. Maximum percentage of germination of pollen grains under artificial culture takes place in 7.5% sugar-agar concentration.

Stigma is receptive 12 hours before the flower opens and remains so for 24 hours. Ovary is trilocular with several anatropous bitegmic ovules which have a beaked nucellus at maturity. The inner integument is two cell layers thick while the outer is many layered. A single megaspore mother cell which develops in each ovule becomes deep seated by the division of the parietal cells. Linear and rarely T-shaped tetrads are formed. Chalazal megaspore functions and after 3 divisions forms an 8/-nucleate embryo sac consisting of 2 synergids, an egg, 3 antipodals and 2 polar nuclei.

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Hydraulic Conductivity of Salted Soils.

Ram Neti Singh and Bansh Raj Tripathi.

It is very well known that water is contained in all living tissues, and plants absorb more of it than of any other soil constituents. Water is the largest single constituent of plants making up on an average 75% or more of green plant tissues. Nutrient availability, photo-synthesis and above all growth processes of plants are intimately related to the supply of moisture. For this supply of moisture to the plants, soil functions as a reservoir, in which water enters when rain or irrigation is applied. In view of the over-whelming importance of soil water to plants, it is pertinent to investigate the features of water entry into the soil. The present communication is intended to throw some light on Hydraulic conductivity characteristics of salted soils.

I. Hydraulic conductivity measurements.

This physical property of soil has been considered as one of the very good tests for evaluating land for agriculture and a number of workers (1, 2, 3, 4) have carried out this measurement. The water flow takes place in accordance with the equation :—

$$\frac{Q}{t} = K A \frac{\Delta H}{\Delta L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

where, Q=Volume of water passing through the soil in time 't'.

A=Area of the soil column.

K=Average hydraulic conductivity in the soil interval. (Δ L) over which there is a hydraulic-head difference (Δ H).

Solving for hydraulic conductivity, we have,

$$K = \frac{Q}{At} \cdot \frac{\Delta L}{\Delta H} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2).$$

It may be noted that ΔH must be measured from the surface of water standing on the soil to the elevation at which water will stand during the flow test in a riser or manometer connected to the bottom of the soil column. The length of the soil column is measured during or after water flow and not when the soil is dry. The apparatus

for this measurement was made in the laboratory with the constructive assistance of Prof. W. R. Schoonover (Advisor Soil Science Research Centre, Bichpuri, Agra) after the manner recommended by United States Salinity Laboratory (Agriculture Hand Book No. 60.)

II. Plan of work.

Since it was intended to investigate the hydraulic conductivity-characteristics of Soils, particularly of salted soils, soil samples of varied textures were obtained from different places of the state (U. P.) and following measurements were made in the laboratory.

(1) Electrical conductivity of the extract of saturated soil pastes.

(2) PH of the soil water suspension (1 : 5).

(3) Exchangeable Sodium percentage and

(4) Hydraulic conductivity.

The results of salinity status, and Hydraulic conductivity—measurements are detailed below in Tabular form.

III. Observations.

A. In the table I below, are shown the observations for the soil samples (Normal Soil) taken from our Bichpuri Farm.

TABLE I. (Normal Soil).

1	2	3	4	5
Depth Inches.	Electrical conductivity m mhos/cm. (E. C.)	PH.	Ex. Na. %	Hydraulic conductivity (K) cm./hour per Unit hydraulic gradient.
6″	0.60	8.7	negligible	1.88
18″	1.00	7.8	,,	0.72
36″	1.25	7.9	,,	0.66

B. In the table II, are recorded the observations for the soil samples from Bichpuri Farm. These samples belonged to the saline area of the Farm.

TABLE II. (Saline Soil)

1	2	3	4	5
Depth	Electrical conductivity (E. C. m. mhos/cm)	PH.	Ex. Na. %	Hydraulic conductivity K. cm/hour per unit Hy. Grad.
6″	1.5	7.6	0.0	4.24
18″	5.0	7.8	5.0	3.14
30″	9.0	8.1	0.0	1.94
36″	8.0	8.0	3.3	1.28

C. The observations shown below in table III are for soil samples taken from Govt. Mechanised State Farm Niblett (Lucknow). These soils are affected by sodic problem.

TABLE III. Sodic Soil (Alkali)

1	2	3	4	5
Depth	E. C. m. mhos/cm.	PH.	Ex. Na. %	K. cm./hr. per unit Hy. Grad.
6″	1.0	10.0	49	0.129
18″	2.2	10.5	87	Very low
30″	1.8	10.3	71	0.024

D. Table IV, records the observations for soil samples from Govt. Mechanised State Farm Nilgaon, (Sitapur). These samples are classed as saline-alkali :

Table IV. (Saline-Alkali)

Depth	E. C. m. mhos/cm.	PH.	Ex. Na.%	K. cm/hr. per unit Hy. Grad.
Top	42.2	10.3	43	0.045
6″	14.5	10.3	61	0.085
18″	13.4	10.1	31	low
30″	9.0	10.0	64	v. low

E. Table V contains the observations for soils of Nilgaon Farm from a different area (different texture).

Table V. (Saline-Alkali and alkali samples)

Depth	E. C. m. mhos/cm.	PH	Ex Na.%	K. cm/hour per unit Hy. Grade
Top Scrap	125	9.9	92.0	1.84
6"	8.5	10.5	51.0	low
18"	4.4	10.2	33.3	0.21
30"	2.2	10.1	27.0	0.09

IV. Discussion of Results.

(1) The observations for normal soils as contained in the table I, show that hydraulic conductivity is maximum for the upper 6" depth of soil and it decreases gradually for soils from lower depth. Secondly the values are quite good for crop production, for ordinarily values for hydraulic conductivity upto .025 cm/hour are considered satisfactory. For normal soils, the hydraulic conductivity, is primarily dependent on soil texture. The decrease in the values of hydraulic conductivity (k) with depth can be attributed to the following factors :—

(*a*) The upper 6" of the soil is acted upon by crop roots, microbial activities, organic matter and tillage operations much more than the soil of lower depths. It is therefore, expected that the values of K will be higher for the upper few inches of the soil.

(*b*) Usually the texture of the soil in the upper few inches is modified due to the operations and additions indicated above. The soils lower, continue to maintain heavier texture.

(*c*) *Compression* :—various workers (4, 5) have shown that compression by over lying soil-layers will reduce the hydraulic conductivity value ;

Thus it will be seen that the observations are quite consistent with our expectations.

(2) The observations in table II show that the values of E. C. (Electrical conductivity of the saturated soil extract) are higher than 4 m. mhos and the exchangeable sodium percentage (Ex Na.%) is considerably lower than 15. Hence the soil is only saline and no sodic problem. The values for PH, are also in confirmity with this conclusion. The observations in the last column of table II, show that here again the values of K, are decreasing with depth. The soil under consideration in this table

was of the same texture as in table I. The PH values in both the cases are the same. The only difference in the two soils is that the values of E. C. in this case are considerably greater than 4 m. mhos/cm and hence it is a saline soil. The salinity manifests its effect through the values for hydraulic conductivity shown in column 5. It will be seen that the values for K in the case of saline soil are 3 or 4 times greater than those for normal soil shown in table I. The observations in this section, show a marked and pronounced influence of salinity on hydraulic conductivity.

(*c*) For the soil of the Niblett Farm (Lucknow) shown in table III. E. C. is less than 4 m. mhos/cm, PH is considerably greater than 8.5 and exchangeable Na% is 3 to 6 times higher than 15%. Obviously the soil is sodic, exclusively and intensively. The percentage of ex. Na has a very marked and distinct adverse effect on hydraulic conductivity. The values of K shown in column 5 of table III, are decreasing with depth as in previous cases, but the high exchangeable sodium percentage (Ex Na%) has considerably reduced the hydraulic conductivity. It will be seen that maximum value of K in this case is 0.129 cm/hour which is nearly half the minimum value. (0.25 cm/hour) recommended for crop production. Obviously under this condition, water entry in the soil will be so slow that most of the irrigation water will be lost by evaporation and a very small quantity of moisture will be able to enter the soil with the result that the plants grown on this soil, will always be in trouble for moisture unless suitable amendments are made to replace ex. Na. The coulumn 5 shows that with 49% ex. Na, K = O.129, with 71% ex. Na, K = .024 cm/hour and with 87% ex. Na, K = very low (could not be measured in reasonable time). Thus hydraulic conductivity values are found to be decreasing with increasing ex. Na%.

(4) The observations recorded in table IV are for Nilgaon Farm (Sitapur). It is a typical example of high saline alkali soil, since EC = 3 to 14 times higher than 4 m. mhos/cm, PH is considerably greater than 8.5 and ex. Na% is 2 to more than 4 times greater than 15%.

Here opposite influences of salinity on the one hand, and sodic problem on the other, are operating. The salinity is helping hydraulic coductivity, but the sodium problem is counteracting it, to such an extent that the values of K are less than 1/5 to extremely lower than the minimum value of K for crop production. This situation is very unsatisfactory because under such circumstances, the water entry into the soil will be very very slow and what-ever moisture finds its way into the soil, will not be easily available to plants due to the high osmotic pressure developed in the soil solution which when added to the normal soil moisture tension, will make the total soil moisture stress considerably greater.

(5) The observations shown in the last table V are also for the soil of Nilgaon Farm but of some different texture. The first observation in the table is for the

surface scrap soil for which E. C. is very very high = 125 m. mhos/cm. The ex. Na% too is very great = 92%. Such a high ex. Na % should have made the value of K extremely low but the value of K is fairly high = 1.84 cm./hour. This is because of high salinity which has its influence on hydraulic conductivity, opposite to that of sodic problem. The second observation in this table shows that when salinity has decreased to E. C. = 8.5 m. mhos/cm, with 51% of ex. Na, the hydraulic conductivity has been reduced to negligible value indicated "low" in column 5. These two observations of table V show marked counteracting effects of salinity and alkalinity of soils on hydraulic conductivity.

V. Summary and Conclusion.

Since appropriate values of hydraulic conductivity are very essential for good crop production, it is necessary to adopt suitable soil management practices to obtain proper hydraulic conductivity. The factors which influence this property of soils are :—

(1) Texture (2) Depth (3) Salted problems (Saline, saline-alkali and alkali or sodic) and (4) methods of cultivations. In this paper texture, depth and salted problems have been considered in relation to hydraulic conductivity. From the section on discussion, it is evident that although texture is a dominant factor in determining hydraulic conductivity, the salt status has consiberably marked effect on this property. When the soil is saline, hydraulic conductivity is much greater than that of normal soils although the texture is the same. When there is exclusively sodic problem i. e. when the exchangeable Na is greater than 15% in the soil, the hydraulic conductivity is considerably decreased. The decrease may be in proportion to the ex. Na %. High exchangeable sodium percentage may cause the hydraulic conductivity to be so low that water entry into the soil may be completely stopped. Under such a situation even with good and frequent irrigation, the plants may not get adequate moisture for their survival and growth. There is a third situation in salted soils, where saline and sodic problems both exist together. Under this situation, salinity tries to increase hydraulic conductivity, while alkalinity tends to decrease it. Thus the effects of the two problems have contradictory effects on the hydraulic conductivity. It should be noted that sodic problem retards entry of water in the soil while salinity hazards prevent up take of water by the plants from the soil. Thus it is evident that salt-status of soil has very significant influence on the hydraulic conductivity. Hence for successful crop-production, suitable amendments and practices must be applied to counteract the adverse effects of salt problems on hydraulic conductivity.

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Condensation of Aldehydes with Phenylacetic Acid.

R. N. Singh, K. K. Reddy, and U. P. Singh

Part II—Condensation of piperonal with Phenylacetic and p—nitrophenylacetic acids.

Abstract.

Condensation of piperonal with phenylacetic and p-nitrophenylacetic acids has been successfully achieved. Two new products have been obtained. The Condensations were attempted in presence of four different catalysts, viz. pyridine, piperidine, triethanolamine—alone as well as in combination with acetic anhydride, and piperazine. Here again the superiority of a secondary base over a tertiary one has been found. The nitro group has been found to have a positive influence on the reaction whereas methylene dioxy behaves to the contrary.

The condensation reaction generally taking place between the carbonyl group of an organic substance and the reactive methylene group of another is historically known as "Perkin's reaction." This reaction was for the first time used in 1868 by Perkin for the preparation of the valuable perfume coumarin by heating Salicylaldehyde with sodium acetate and acetic anhydride.[28] Although similar methods had been used for preparing cinnamic acid by Bertagini (1856)[4] by heating benzaldehyde with sodium acetate and acetyl chloride in a sealed tube at 120-30°, and by Schiff (1870)[33] by heating benzaldehyde with acetic acid and hydrochloric acid or Zine Chloride in a sealed tube at 110-20°, it is Perkin's method alone which has survived and attained a classical status by its very wide application in synthetic organic Chemistry, inspite of its undergoing modifications from time to time.

The mechanism of Perkin's reaction remained a controversial issue for some time. Perkin had suggested that the condensation reaction took place between the aldehyde and the anhydride employed, and the Sodium salt acted merely as a catalyst [29, 30]. Fittig [10, 12] contested Perkin's view and asserted that it was the sodium salt which condensed with the aldehyde and that the anhydride served only to absorb water liberated during the reaction. Fittig's side was taken by Stuart (an Englishman then working in Fittig's laboratory), who obtained cinnamic acid by the condensation of benzaldehyde by using sodium malonate in place of sodium acetate ; when sodium isosuccinate was substituted for the malonate, isophenylcrotonic acid was obtained[36, 37, 38]. Fittig's view was generally accepted upto 1928, and the controversy was brought to an end by Breslow and Hauser[6], when they finally established that Perkin's interpretation was the only correct explanation.

Stuart also showed that in Perkin's reaction glacial acetic acid at 110° could also be used with better results instead of acetic anhydride at 180°. This method was then used by several workers, like Komnenos[20], Stuart[38], Fittig and Mackenzie[11] and others. Michael[26] could obtain satisfactory yields by heating an aldehyde with malonic acid alone in a sealed tube for several hours at 140°. It would thus appear that Stuart deserves the credit for introducing malonic acid as one of the reactants in Perkin's reaction, and glacial acetic acid as a catalyst.

The next important change was due to Knoevenagel (1898)[17], [19] when he introduced a base, organic or inorganic, as a condensing agent in place of glacial acetic acid. The inorganic base used was ammonia in the form of alcoholic ammonia, ammonium malonate or chloride. The organic bases were either primary amines like aniline and ethylamine, or the secondary ones like piperidine and diethylamine. The inorganic and the organic primary bases were used in full molecular or even larger proportions, while the secondary ones were used in smaller proportion only ; thus "piperidine in a few drops" has come to be known as Knoevenagel's reagent. Knoevenagel extended his work to include several other compounds such as malonic ester, acetoacetic ester, cyanacetic acid and ester etc., all containing the reactive methylene group.

It is surprising that the use of tertiary bases, like pyridine, did not strike Knoevenagel, especially when at about the same time Verley (1899)[10] had started using it, and soon afterwards Doebner (1900)[8] and others had also used it. In fact Harding and Weizmann[14] specially recommended the use of a tertiary base, like pyridine, because by its use as a catalyst he succeeded in preparing nonylenic acid from heptaldehyde, where Perkin's method and Knoevenagel's primary and secondary bases gave a very poor yield of mixed products. In these condensations pyridine was generally used in full molecular proportions or even in greater excess. Staudinger[35] recommended the use of anhydrous pyridine in dry ethereal solution and Florence[13] used this method for preparing $\alpha\beta$—unsaturated acids.

On the suggestion of Robinson (1924) Perkin (Junior) used a combination of pyridine and piperidene as a condensing agent and in collaboration with Haworth and Rankin[16] succeeded in obtaining 85% yield of 3 : 4-methylenedioxy cinnamic acid by employing piperonal, malonic acid and pyridine in 1 : 2.5 : 6 mol. proportions with a small amount of piperidine. Perkin's method in this case had given an yield of 30% only. Later on (1925) Robinson and Shinoda[32] recommended 3.5 mols. of pyridine for one of the aldehyde.

Pandya and Surange (1934)[23], however, failed to induce condensation of Salicylaldehyde with malonic acid by using molecular proportion of pyridine as a condensing agent. Dutt[9] got a similar result by using a pyridine—piperidine mixture.

Yet some earlier workers like Knoevenagel,[18] Perkin,[29] and stuart[36] had reported condensation of Salicylaldehyde. This then led Kurien and Pandya[23] to reinvestigate the problem of the condensation of hydroxybenzaldehydes with malonic acid. They succeeded by using 0.15 mol. of pyridine instead of one whole molecule. This thus led to the discovery of pyridine—trace as an efficient catalyst, which was subsequently amply demonstrated by Pandya and coworkers by using it with a number of aldehydes.

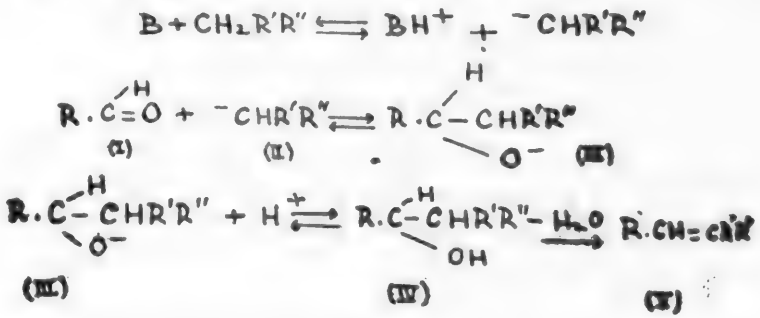
In 1950 work was started in this laboratory by using phenylacetic acid in place of malonic acid. Observations made in a number of condensations showed that pyridine—trace was not as good a catalyst as it was found to be in malonic acid condensations ; piperidine—trace (a secondary base) fared better than pyridine, e. g. benzaldehyde,[34] anisaldehyde,[34] Vanillin,[25] p—hydroxybenzaldehyde,[22] o—methoxybenzaldehyde,[22] m—methoxybenzaldehyde,[21] etc. gave respectively 63.3%, 68.5%, 36.8%, 45.3%, 63% and 71.1% yields with piperidine—trace whereas no condensation occurred at all by using pyridine—trace. In several other cases also the use of piperidine, by and large, has given higher yields than pyridine. We have also tried two other tertiary bases, namely triethylamine and triethanolamine. They have also been found to behave like pyridine.

The role of bases as catalytic agents is now an established fact. Bacharach and Brogan (1928)[3] for the first time referred to the catalytic activity of pyridine and Boxer and Linstead (1931)[5] emphasised that tertiary bases had a definite catalytic activity.

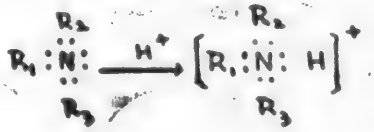
As regards the mode of working of the bases Knoevenagel[17] believed that the organic base NH_2 R′ or NH R′ R″ first combined with the aldehyde, R. CHO, to produce intermediate products of the type R. CH (OH) NH_1R′, R. CH (NHR′)$_2$ and R—CH (NR′R″)$_2$ which in turn reacted with the methylene group component viz. malonic acid, phenylacetic acid or acetoacetic ester. Knoevenagel's mechanism fails to explain the case of a tertiary base as it does not contain a hydrogen atom and thus cannot react with an aldehyde.

The correct mechanism of such a reaction, showing the base as a catalyst, was first given by Lapworth[24] and was subsequently confirmed by Arndt and Eistert[2] and finally by Hauser and Renfrow[15]. According to this the reactive methylene group ionises to give hydrogen ion, which combines with the base B to form BH^+ and the anion (II). The latter then adds to the aldehyde molecule resulting in the formation of the anion (III). The BH^+ then dissociates to give the hydrogen ion

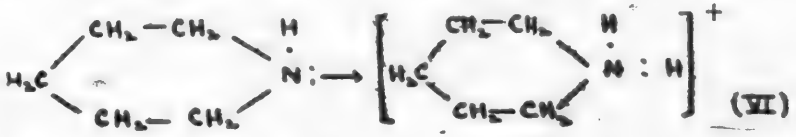
which adds to (III) forming (IV) and the base B is regenerated. (IV) then loses water to give the unsaturated condensation product (V)[1] :



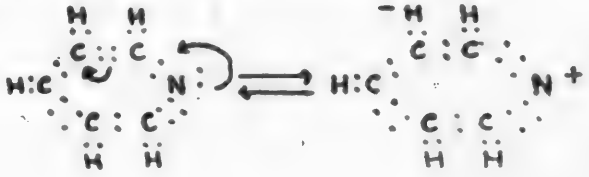
The above mechanism shows that an organic base, whether primary, secondary or tertiary, will accept a hydrogen ion from the reacting methylene group due to the presence of the lone pair of electrons on the nitrogen atom, which provides a seat for attachment.



The availability of this lone pair of electrons of nitrogen will depend on the constitution of the base. In the saturated base piperidine the lone pair will always be available for the hydrogen ion to produce the piperidonium cation (VI).



The case of pyridine is different. It contains a "hetero—enoid" system N—C=C, in which the lone pair of electrons on nitrogen appears to be in conjugation with the rest of the system (Compare Robinson)[31].



It is thus evident that the lone pair of electrons is less available in pyridine, and this fact makes pyridine less effective as a catalyst than piperidine[27]. The inference drawn from the work done in this laboratory by using phenylacetic acid, cited above, is fully in line with the above theoretical expectation. The secondary base piperidine has been found to be a more efficient catalyst than the tertiary pyridine, triethylamine or triethanolamine.

From a study of the condensation reactions it has been seen that the following factors affect them : (i) the nature of the base used as a catalyst (ii) the nature of the aldehyde and the substituent groups present on the benzene nucleus in the case of aromatic aldehydes and (iii) the nature of the substance containing the methylene group. Besides these there are other minor factors such as temperature, time, concentration and the solvent.

The object of the work described here is to report two organic compounds which have been obtained from the condensation of piperonal with phenylacetic and p—nitrophenylacetic acids, as well as to study the comparative efficacy of the bases used, viz, pyridine, piperidine, piperazine and triethanolamine used alone as well as in combination with acetic anhydride, and thirdly to study the influence of the nitro and methylene dioxy groups on condensation reactions.

For the purpose of comparison condensation with malonic acid may be taken as the standard. Kurien[23], Vahidy[39] and Pandya obtained quantitative yield of piperonylacrylic acid in four hours at 100° by condensing piperonal with malonic acid in presence of pyridine—trace. Piperonal has now been condensed with phenyl acetic and p—nitrophenylacetic acids by us, the products obtained are 3 : 4—methylene dioxy—α—phenyl cinnamic (m. p. 233° C) and 3 : 4—methylene dioxy—α—(p—nitrophenyle)—cinnamic acids (m. p. 260—62°C). The maximum yield in the case of the former product was 37% obtained by heating piperonal and phenylacetic acid in molecular proportion for 12 hours at 170°C in presence of Piperidine—trace as a catalyst. Pyridine in traces, in molecular proportion or in combination with piperidine completely failed as a catalyst. A second tertiary base triethanolamine, alone as well as in combination with acetic anhydride also failed completely. Another base piperazine, although it is a secondary one, gave only 18% yield of the condensation product, but in any case it fared better than the tertiary ones.

In condensations of piperonal with p—nitrophenylacetic acid the maximum yield of 33.3% was obtained by using a mixture of triethanolamine and acetic anhydride as the catalyst. Here too pyridine failed completely, piperazine came next in order of efficacy giving 10% yield in 18 hours at 140° C, while piperidine did still better. The observations regarding the supremacy of secondary over tertiary bases in the matter of their efficacy are perfectly in line with the theoretical expectation mentioned earlier. Buckles, Ballis and Codler[7] had observed that the catalytic activity

of tertiary bases is much improved by mixing them with acetic anhydride. Results obtained in condensations with p—nitrophenylacetic acid here as well as with some other aldehydes attempted in this laboratory confirm the inference of the above workers. (See Table 3.).

The effect of the methylene dioxy group on condensation, so far as judged by the results obtained by Pandya and Co-workers[23, 39] in condensation with malonic acid, can be said to be positive. In condensations with phenylacetic and p-nitrophenylacetic acids the results obtained indicate an entirely opposite trend. With the former acid piperonal gave a maximum yield of 37% in presence of piperidine—trace as a catalyst and no condensation occurred by using acetic anhydride in combination with a tertiary base. It is surprising that the latter catalyst completely failed here although it has proved a great success in many other cases. When these results are compared with those obtained in benzaldehyde—phenylacetic acid condensations, that is 68.5% yield in presence of piperidine—trace and 79.5% with a mixture of triethylamine and acetic anhydride, the influene of methylene dioxy group is clearly negative. In condensations with p—nitrophenylacetic acid piperonal gave a maximum yield of 33.3% by using a mixture of triethanolamine and acetic anhydride whereas no condensation occurred with phenylacetic acid under similar conditions. This shows the positive influence of the nitro group in increasing the yield, and confirms the observations of Buckles, Ballis and Codler[7] made in the case of other aldehydes.

Experimental.

The general procedure was to take piperonal and phenylacetic acid or p—nitrophenylacetic acid (1 : 1 mol.) in a 100 c.c. round bottom flask and to add the catalyst to this in the required proportion. The reaction mixture was heated at a particular temperature for a certain length of time. Different bases were tried and different temperatures and periods of heating were resorted to find the optimum conditions for maximum yield.

Condensation with phenylacetic acid.

The following table (Table I) gives the yields of 3 : 4—methylenedioxy—α—phenylcinnamic acid obtained under different experimental conditions. The reaction-mixture after the reaction was generally left overnight and then treated with 10% solution of sodium bicarbonate and warmed. After cooling the unreacted aldehyde was removed by ether treatment. The solution an acidification with hydrochloric acid precipitated the condensation product, which on crystallisation with absolute alcohol melted at 233° C. The product was found to be an acid. Eq. Wt. found=268.1, $C_{16}H_{12}O_4$ requires 268.

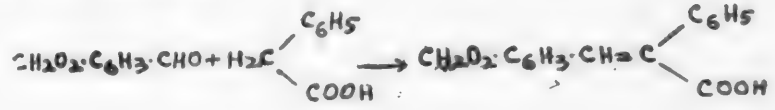


TABLE 1.

S. N.	Base	Mol. prop.	Time hrs.	Temp. C.	Yield %
1.	Pyridine	1 : 1 : 0.15	24	170	nil
2.	„	1 : 1 : 1	24	170	nil
3.	Piperidine	1 : 1 : 0.15	12	170	37
4.	„	1 : 1 : 0.15	4 weeks	Room temp.	nil
5.	„	1 : 1 : 1	18	170	7
6.	Triethanolamine	1 : 1 : 0.15	24	170	nil
7.	„ $+Ac_20$	1 : 1 : 1 : 3	24	170	nil
8.	Piperazine	1 : 1 : 0.15	6	140	18
9.	„	1 : 1 : 1	12	140	9
10.	Pyridine+piperidine	1 : 2 : 3 : 0.15	2	100	nil

Condensation with p—nitrophenylacetic acid.

p—nitrophenylacetic acid was prepared from benzyl chloride by converting it into benzyl cyanide followed by nitration and hydrolysis.[41]

The yields of 3 : 4—methylene dioxy—<— (p—nitrophenyl) cinnamic acid obtained with different catalysts are given in Table 2. The condensation product was extracted by the method described above and purified by recrystallisation with absolute alcohol and acetone. It melted at 260—62°C with charring. It decolourised bromine water and was found to be an acid. Equivalent wt. found=312.68, $C_{16}H_{11}O_6N$ requires 313.

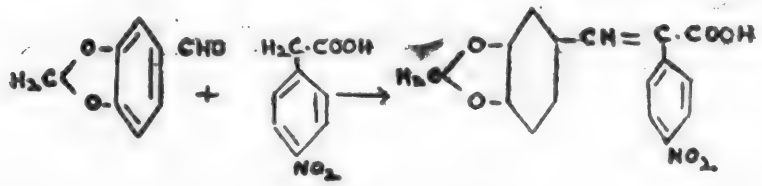


TABLE 2.

S. N.	Base	Mol. prop.	Time hrs.	Temp. °C	Yield %
1.	Pyridine	1 : 1 : 0.15	24	170	nil
2.	,,	1 : 1 : 1	24	170	nil
3.	Piperidine	1 : 1 : 0.15	12	120	26.7
4.	,,	,,	4 weeks	Room Temp.	nil
5.	,,	1 : 1 : 1	12	120	nil
6.	Triethanolamine	1 : 1 : 0.15	24	170	nil
7.	,, + AC_20	1 : 1 : 1 : 3	24	170	33.3
8.	Piperazine	1 : 1 : 0.15	18	140	10
9.	,,	1 : 1 : 1	18	140	6.6
10.	Pyridine + piperidine	1 : 2 : 3 : 0.15	2	100	nil

TABLE 3.

Table showing maximum yields under different conditions in condensations of piperonal with phenylacetic and p— nitrophenylacetic acids.

	Condensing agent	Time hrs.	Temp. °C	Yield. %
Phenylacetic acid	Pyridine—trace	24	170	
	Pyridine (mol. prop.)	24	170	
	Robinson & Shinoda's[32] method	2	100	
p—Nitrophenylacetic acid	Pyridine—trace	24	170	nil
	Pyridine (mol. prop.)	24	170	
	Robinson & Shinoda's[32] method	2	100	
Phenylacetic acid	Piperidine—trace	12	170	37
	,, ,,	4 weeks	Room Temp.	nil
	Piperidine (mol. prop.)	18	170	7
	Triethanolamine	24	170	nil
	Triethanolamine + AC_20 (mol. prop. 1 : 3)	24	170	nil
	Piperazine—trace	6	140	18
	,, (mol. prop.)	12	140	9

(Contd.)

	Condensing agent	Time hrs.	Temp. °C	Yield %
p—Nitrophenylacetic acid	Piperidine—trace	12	120	26.7
	,, ,,	4 weeks	Room temp.	nil
	,, (mol. prop.)	12	120	—
	Triethanolamine+	24	170	nil
	,, Ac_2O (mol. prop. 1:3)	24	170	33.3
	Piperazine—trace	18	140	10
	,, (mol. prop.)	18	140	6.6

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Notes

An Introduction to the Research work done at Balwant Vidyapeeth.

From the time it decided to set up departments in the faculties of Science and Agriculture, Balwant Rajput College has had before it an integrated programme of teaching, research and extension for these departments. Fully appreciating the value of research in strengthening the teaching programmes in the different disciplines and for furnishing the material for the extension activity of the institution, post graduate departments in Science and Agriculture have gradually been developed since 1945.

The first department to organise post graduate teaching and research was Agricultural Economics in July 1945 followed by Agronomy and Botany in 1947, Horticulture, Animal Husbandry and Dairying, Zoology and Chemistry in 1949.

Eversince the postgraduate classes started in the college the research work both at postgraduate and doctorate level is in progress. The topics on which the work has been done in different departments are of the following nature :

Branch of Study	Areas of Research
Agricultural Economics.	1. Agricultural Economy of the regions. 2. Land problems and irrigation. 3. Economics of type and scale of farming. 4. Cultivation and yield of crops. 5. Agricultural labour, earnings and employment. 6. Agricultural finance. 7. Co-operation. 8. Marketing and prices. 9. Socio-economic Studies.
Agronomy.	1. Manurial and Irrigational. 2. Varietal and manurial. 3. Weeds and weed control. 4. Drought resistance. 5. Dry farming and water requirements. 6. Presowing seed treatments.

Branch of Study	Areas of Research
	7. Cultural. 8. Soil salinity. 9. Mixed cropping and rotational. 10. Miscellaneous.
Botany.	1. Morphology and seed anatomy. 2. Embryology. 3. Physiology. 4. Cytogenetics.
Animal Husbandry & Dairying.	1. Chemistry of milk and milk products. 2. Technology of dairy products. 3. Dairy Economics. 4. Animal nutrition. 5. Reproductive physiology.
Horticulture.	1. Propagation, manuring, set and drop, parthenocarpy and storage of fruits. 2. Cultural Treatments, and parthenocarpy of vegetables. 3. Floriculture.
Chemistry.	1. Perkin and Knoevenagel reactions. 2. Study of Hydroxymethylene ketones. 3. Study of chromous salts and reducing agents.
Zoology.	1. Morphology of insects. 2. Cytology. 3. Bionomics and life history of insects—Nature of damage and remedy.

The exact titles of the works (theses or reports) will be published gradually in the subsequent issues of the Journal.

Certain research projects have been completed under the grants from Central Government, State Government, Scientific Research Committee U. P., I. C. A. R. and other organizations. An account of these projects has been given in the following table :

Branch of Study	Title of the Research Project	Financiers
Agricultural Economics	Enhancement of farm production.	Scientific Research Committee, U. P.
Agronomy	1. Model Agronomic Experiments Scheme.	I. C. A. R.
	2. Model Weed Control Scheme.	I. C. A. R.
	3. Improved Implements Scheme.	I. C. A. R.
	4. Soil Salinity,	I.C.A.R. & T.C.M.
Botany	1. Eradication of Banda parasite.	I. C. A. R.
	2. Morphological Studies in Simerutaceae Burseraceae and Meliaceae.	Scientific Research Scheme, U. P.
Animal Husbandry & Dairying	Scheme on the Nutritional Requirements of Buffaloes	I. C. A. R.
Horticulture	Breaking dormancy in Potato tubers.	Scientific Research Scheme, U.P. Govt.
Chemistry	1. "Cyclisation in condensation reactions".	Central Govt.
	2. "Cyclisation in condensation reactions" (a two years scheme).	Scientific Research Committee, U. P.

Apart from the research projects subsidized various organizations and governments several other research projects have been taken up by different departments of Science and Agriculture themselves. They are of the following nature.

Agricultural Economics :

(1) Land Utilization in U. P. (with reference to enhancement of food production in U. P.)

(2) Value and Output of Some Minor Products in Agriculture (for National Income Committee)

(3) Cost Studies (for National Income Committee).

Agronomy :

(1) Varietal trials on wheat, barley, maize and Joar.
(2) Permanent Manurial Trials.
(3) Sewage Irrigation Experiments.

Botany :

(1) Comparative morphological and embryological studies of the members of maydeae and their hybrids.
(2) Comparative biochemical (cytochemical) studies of the gametophytes of the members of the Maydeal and their hybrids.
(3) Studies in the causes of incompatibility in the species hybrids in *Crotolaria* and other pulses.
(4) Investigations on the mode of aponixis in *Plantago* species.
(5) Distribution and behaviour of B. chromosomes in *Plantago* species.
(6) Cytological Studies in Andropogoneae.
(7) Morphological and embryological studies in Cucurbitaceae.
(8) Biochemical studies of the various haustorial structures in the female gametophyte of Angiosperms.
(9) Morphological studies in the family Rosaceae.
(10) Morphological studies in the family Bignoniaceae.
(11) Morphological Studies in family Umbelliferae.

Animal Husbandry & Dairying :

(1) Phospholipids of milk and their distribution in milk products.
(2) Effect of Energy levels on the utilization of roughages by ruminants.

Horticulture :

(1) Vegetative propagation of fruit plants, chiefly by rootage.
(2) Induction of parthenocarpy in fruits and vegetables.
(3) Soil fertility and plant population relationships in vegetable crops.
(4) Transplanting of vegetable crops.

Chemistry :

(1) Studies in the synthesis of benzopyrilium derivatives.
(2) Studies in condensation reactions between phythalic anhydride and acylated glycines.
(3) Studies in condensation reactions between hippuric acid and hydantoin with aldehydes.

A number of original books, monographs and research papers have been written by the members of the staff and postgraduate students of the college. The following table shows the number of these publications together with that of theses submitted from different departments of the college.

Branch of Study	No. of books and monographs	No. of research papers	No. of theses at Doctorate level	No. of theses at postgraduate level
Agricultural Economics	2	35	2	84
Agronomy	—	30	3	133
Botany	—	70	6	21
Animal Husbandry & Dairying	—	4	—	69
Horticulture	—	6	1	70
Chemistry	—	18	—	22
Zoology	—	12	3	10

Further more the B. R. College, Agra had been selected by the I. C. A. R., U. P. Government and Illinois University Survey team as a centre for developing salinity research in view of the salinity problems both due to salts in the soil and water of poor quality in the area. The soil salinity laboratory located at Bichpuri—a village seven miles from Agra—is making a good progress in salinity research. An Agricultural Engineering Workshop, financed by the Central Govt. is also functioning at Bichpuri. The purpose of this workshop is to advance research and prepare agricultural tools which are improved, cheap and more economical.*

*A detailed history of the soil salinity laboratory and the Agricultural Engineering Workshop will be published in subsequent issues of the Journal.

A List of Theses Submitted to the Agra University Through the B. R. College in 'Agricultural Economics' (Till 1958)

CLASSIFICATION OF THE THESES

(At post graduate level)

Class No.	Title of the Class	No. of Theses written
I	Agricultural Economy of the regions	3
II	Land problems and Irrigation	14
III	Economics of type and scale of farming	12
IV	Cultivation and yield of crops	12
V	Agricultural labour, Earnings and Employment	11
VI	Agricultural finance	6
VII	Cooperation	3
VIII	Marketing and prices	5
IX	Socio-Economic studies	7
	(At Ph. D. level)	
I	Agricultural Economy	2
II	Agricultural Labour	2

The details of the titles of theses in each of the above class are given in the following pages.

S. N.	Title of the Theses	Year
	I. Agricultural Economy.	
1	Agricultural Economy of Mewar	1948
2	Agricultural Economy of Gwalior State	1949
3	Agricultural Economy of the Narbada Valley	1951
	II. Land Problems.	
1	Soil erosion and its control in U. P.	1948
2	Development of Tenancy rights in U. P.	1950
3	Land Utilization in Jhansi District	1950
4	Land Utilization in Etawah District	1950
5	Land Tenures in Mewar	1950
6	Land Utilization in Orissa	1952
7	Land Problems in Travancore-Cochin State	1955
8	Planning the land-use in Burdwan District	1957
9	Consolidation of holdings in Mathura District	1957
10	Land Utilization in Ravine areas	1957
11	Land management after Zamindari abolition	1958
	Irrigation.	
1	Well irrigation in U. P.	1947
2	Tube well irrigation in U. P.	1948
3	Canal irrigation in U. P.	1949

S. No.	Title of the Theses	Year
	III. Type and Scale of Farming.	
1	Economics of mixed farming in Meerut	1947
2	Economics of mixed farming in Mathura District	1949
3	Income and cost in relation to size of holdings	1950
4	Efficiency of agriculture on various sizes of holdings in Meerut District	1951
5	Agriculture as a subsidiary occupation	1952
6	Economics of mixed farming in Bijnor District	1952
7	Agriculture for town dwellers	1956
8	Motives in farm production activities	1957
9	Experiments in large scale mechanized farming in Agra District	1957
10	An experiment in Cooperative farming	1958
11	Role of minor crops in farming programme	1958
12	Economics of live-stock industry in U.P. (Economics M.A.)	1948
	IV. Cultivation and Yield of Crops.	
1	Trends and crop yields in U. P.	1947
2	Possibilities of extension of Agriculture in Agra Division	1948
3	Crop and cropping patterns in Western U. P.	1948
4	Sugarcane cultivation in Meerut District	1949
5	Sugarcane cultivation in Gorakhpur District	1949
6	Food position in U. P.	1951
7	Crop rotation in East U. P.	1951

S. No.	Title of the Theses	Year
8	Mango cultivation in Aligarh District	1951
9	Casual cultivation in the bed of Jamuna in Agra District	1951
10	Wheat cultivation in Malwa	1952
11	Marketable surplus in food crops	1958
12	Agriculture in Doab in Ballia District	1950
	V. Agricultural Labour.	
1	Agricultural labour and wages in U. P.	1947
2	Agricultural idleness in U. P.	1948
3	Agricultural labour in Badaun District	1949
4	Wages and standard of living of agricultural labour in Banaras District	1949
5	Wages and cost of living of agricultural labour in Mainpuri District	1949
6	Agricultural labour in Bulandshahar District	1950
7	Agricultural labour and wages in Jaunpur District	1950
8	Agricultural idleness in Deoria District	1950
9	Distribution of labour and earnings in agriculture (in Meerut)	1951
10	Employment and earnings in Agriculture (in Mathura)	1952
11	Income and standard of living in Meerut District	1952
	VI. Agricultural Finance.	
1	Cooperative finance in Agriculture	1949
2	Agricultural finance in Agra District	1949

S. No.	Title of the Theses	Year
3	Effects of war on rural indebtedness in Meerut District	1950
4	Effect of war on agricultural indebtedness in Etawah District	1951
5	Agricultural investments	1956
6	Distress finance in Agriculture	1957
	VII. Co-operation.	
1	Working of co-operative marketing societies in U. P.	1949
2	Development of co-operative movement in U. P.	1949
3	Place of co-operation in agricultural planning	1950
	VIII. Agricultural marketing and prices.	
1	Agricultural prices with special reference to wheat, rice and sugarcane in U. P.	1950
2	Marketing of cattle in Agra division	1950
3	Marketing of vegetables at Agra	1952
4	Agricultural adaptation to price variations	1952
5	Storage costs and losses in agricultural produce	1956
	IX. Socio-Economic Studies.	
1	Social anatomy of a village community	1952
2	The social system and the changing economic set up	1953
3	Social transition in Rural India (Bichpuri village)	1955
4	Trends and directions of rural change with special reference to scheduled castes	1957

S. No.	Title of the Theses	Year
5	Socio-economic study of an overgrown village	1957
6	Life in a ravine village	1957
7	Living conditions in rural areas in Gorakhpur division	1950

THESES AT Ph. D. LEVEL

S. No.	Title of the Theses	Writer	Year
	I. Agricultural Economy		
1	Indian Farm Economy	D. S. Chauhan	1947
2	Agricultural Economy in the East U. P.	K. D. Upadhyay	1951
	II. Agricultural Labour		
1	Agricultural labour and wages	G. S. Rawat	1953
2	Wages and cost of living of agricultural labour with special reference to West U. P.	S. C. Mathur	1957

The B. V. Journal of Agricultural & Scientific Research

The Journal is published six monthly—in January and July. It publishes, in main, the research papers based on the research work already done and being done in different departments of Agriculture and Science faculties at the Balwant Vidyapeeth Agra, notes regarding the nature of research work being done and being planned, and book reviews.

The books for review should be sent to the Hony. Editor by the end of October and May for the January and July issues respectively.